SCIENCE

FRIDAY, JANUARY 7, 1916

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BOTANY IN RELATION TO AGRICULTURE[1]

IT is the aim of this discussion not merely to show the relation of botany to agriculture, but also to point out on the one hand what botanical investigation has actually done for American agriculture, and on the other, how recent agricultural development has stimulated the science of botany along both educational and investigational lines.

Though much of its practical application passes under such titles as agronomy, horticulture, animal and dairy industry, and soil technology, scientific agriculture depends primarily upon the three fundamental sciences of chemistry, zoology and botany. Of these, botany should and does have the closest relationship with it. This is indicated by the fact that out of 5,500 persons concerned with agricultural teaching and investigation in the U. S. Department of Agriculture and the various agricultural colleges and stations, about 700, or 12 per cent., may be classified as botanists.

There are botanists, however, who are so engrossed in the pure science of their subject that they have little interest in its economic, or, what to-day is almost the same thing, its agricultural relation; on the other hand, there are those working on the practical side who do not appreciate how much the pure science of botany has aided them in their work. We have no quarrel

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, Columbus, December, 1915.

with the former, for whether they realize it or not, all scientific discovery has its ultimate practical bearing. Neither have we any apologies to offer for the so-called practical botanists, for they are the botanists of to-day in the United States, as shown by number of positions occupied and of articles published.

What, then, of this agricultural botany and the factors concerned in its development? Let us first take a brief glance at the closely related subject of the development of agriculture.

AGRICULTURAL DEVELOPMENT

Early History.—Agriculture is unquestionably a fundamental factor in the growth of a nation, therefore as a practise it goes back to the time when men first banded together into societies. But real scientific agriculture, especially as an educational movement in our colleges, is of comparatively recent origin, even more recent than that of botany. Its first educational agencies in this country were a few agricultural periodicals and the various agricultural, horticultural and allied societies that were organized to meet the demands of their time and locality. Schools of agriculture were lacking, and even instruction in existing educational institutions was not provided. Apparently the first or one of the first agricultural schools was that established by the Golds, father and son, at Cream Hill, Connecticut, in 1845, and continued until 1869. About the time of the founding of this school, Norton was appointed professor of agricultural chemistry at Yale, and among his early students were Brewer, the agriculturist, and Johnson, the chemist, both of whom later played such a prominent part in the development of our scientific agriculture. The Bussey Institution of Harvard, although provided for many years previously, did not begin its agricultural work until 1870; but in its earlier publications appeared the investigations of Storer in agricultural chemistry, the work of Farlow with plant diseases and that of Sargent in the Arnold Arboretum. In 1875 Hilgard began his work in California, and in 1880, Henry, in Wisconsin. All of these men were either directly or indirectly interested in botany.

Agricultural Colleges.—The first important factor in this agricultural development, however, was the Morrill Land Grant Act, signed by President Lincoln in 1862, which during the next few years resulted in the founding of our various state universities and agricultural colleges. To-day each state has its university or its agricultural college well established, and many states have both, either as separate or united institutions. Several of the Southern States also have somewhat similar schools of agriculture for their colored population. The various states have backed these institutions with financial aid which now in many cases exceeds that given by the government. For example, one state in its recent biennial appropriations gave to its state university, which includes the agricultural college, five million dollars.

Our agricultural colleges now compare very favorably with those of engineering and arts and science in number of students, professors and courses given. Yet twenty-five years ago they had few students, and a professor of agriculture, another of horticulture, and one of veterinary science, together with the professors of botany, zoology and chemistry as associates, often constituted the entire agricultural faculty. What a contrast to the agricultural staff of to-day, which often exceeds a hundred members, as at the University of California, with 145, Iowa State College with 213, Michigan Agricultural College with 109, Cornell with 189, Massachusetts Agricultural College with 82, and other agricultural colleges with numbers in proportion to the

agricultural development of their respective states. And what a variety of titles these educators bear! The old professors of agriculture, horticulture and botany have been largely replaced by professors of agronomy, dairy industry, animal husbandry, genetics, enology, citriculture, landscape gardening, pomology, olericulture, forestry, bacteriology, plant pathology and a score or so more.

Department of Agriculture.—The second great influence in the development of scientific agriculture in this country was the establishment by Act of Congress, in February, 1889, of a department of agriculture at Washington, and the appointment of J. M. Rusk as its first secretary in the President's cabinet. Since 1862, however, there had been a commissioner of agriculture, and there were already several bureaus or divisions. Even before this for years there had been issued from the Patent Office reports dealing with agricultural information. To-day the department of agriculture comprises, besides various minor groups, bureaus of weather, animal industry, plant industry, chemistry, soils, entomology, biological survey, crop estimates, services of forest and of states relations, and offices of markets and rural organizations and of public roads and rural engineering. To carry on the work of the department, there were in 1913 nearly 15,000 employees, and the annual appropriation was $18,000,000.

Agricultural Experiment Stations.—The third factor in our agricultural development was the establishment of the agricultural experiment stations through the passage of the Hatch Act by Congress in 1886. Even previous to this, there had existed several state stations, that at New Haven, Conn., established in July, 1877, being the first. Each state originally received $15,000 a year from the government, but some years ago this was increased by the Adams Act an additional $15,000, which goes to support the more strictly scientific work. At present most of the stations also receive state aid, which in some cases greatly exceeds that given by the government. For instance, in 1913 the total revenue of the fifty-seven stations in this country was over $4,650,000, and in the case of two of these it reached nearly half a million.

Some idea of the number of investigators employed in stations having no college affiliation is shown by the Ohio station roll, with 64, the Geneva station with 37, and the Connecticut station with 25. Of the stations connected with colleges, California has a staff of 67 employed all or a part of the time in station work, Illinois 88, Wisconsin 84, Kansas 66, and Pennsylvania 49. The literature already issued by the various stations requires one hundred feet of library shelves to hold it, making by itself a very respectable working library in agriculture.

One of the important results of the establishment of experiment stations was the stimulating effect on both the agricultural colleges and the Department of Agriculture. Up to that time the colleges, as a rule, had not taught much agriculture because they had few students; and the department had not yet begun to do much investigational work. By furnishing positions for the agricultural colleges to fill, and by bringing them into closer touch with the farmers, the number of students has been greatly increased and the standing of the colleges much improved; while the rivalry in investigational work between the stations and the department has been of mutual advantage.

Agricultural Extension.—A fourth factor that may greatly influence agriculture in the future is the establishment of the agricultural extension movement, through the Smith-Lever bill, passed by Congress in

May, 1914. One of its chief features, besides the state organization, affiliated with its agricultural college, to direct the work, is the organization of societies in the various counties, with a paid Farm Bureau agent, who shall carry direct to the farmers for practical application the teachings of the agricultural colleges and the results of the investigations of the Department of Agriculture and the experiment stations.

Whether or not this extension service will prove as valuable as have the colleges and stations remains yet to be demonstrated, but it is based in part on results already accomplished in the south. The government has backed the movement with an appropriation of $10,000 a year to each state, this to be gradually increased in proportion to the agricultural population, provided equal sums are appropriated by the state. This means that by the year 1923 there may be spent in this work in the United States over $9,000,000. In most states this will be more money than is spent by the experiment station, and in a few possibly more than is spent by the agricultural college.

BOTANICAL DEVELOPMENT

Early History.—I have gone thus fully into the history of American agriculture because I believe that botany, at least during recent years, has been fundamentally influenced by it. What has been the history of our botanical development? It began with the explorers, usually foreigners, who collected plants and sent them to Europe for identification and description. Then came our native collectors, who finally began to describe the plants they collected. These early workers were interested chiefly in flowering plants, but occasionally there was an individual who worked with fungi or other groups. Local natural history societies in time offered congenial atmosphere for the study of local floras. Eventually governmental aid was given to exploring expeditions. Usually those engaged in botanical work were men who gained their livelihood from some other profession,—doctors, ministers and even lawyers.

First College Instruction.—There were a few institutions, however, that quite early had professors who gave limited botanical instruction and carried on investigations. Some idea of this early botanical work is given by the following notes from five of our oldest educational institutions, furnished the writer by their present botanical heads.

At Harvard, our oldest educational institution, William Dandridge Peck was appointed Massachusetts Professor of Natural History in 1805, and was the founder of the present Gray Botanical Garden. He was both a zoologist and a botanist, and gave lectures in the university. Peck was succeeded in 1825 by Thomas Nuttall, who was director of the botanical garden and lecturer in natural history. Nuttall lived at the Garden, but evidently did not greatly relish his work, as he resigned in 1834. In 1842 the Fischer Professorship of Natural History was founded, and Asa Gray was appointed. This professorship has been since its foundation a botanical position, a fact worthy of mention to our zoological friends, who in these days seem to dominate all the professorships in biology.

At Yale, botany was apparently first taught to a greater or less extent by Dr. Eli Ives, who held a position in materia medica and botany from 1813 to 1829, and a professorship in theory and practise of physic until 1852. He established a small botanical garden, which has since gone out of existence. After Ives's time botanical instruction was lacking until Daniel C. Eaton was appointed professor of botany in 1864, a position he occupied until his death in 1895.

At Princeton, the first instruction in bot-

any was probably given in the closing years of the eighteenth century, by John Maclean, who was professor of chemistry and natural history. From 1824 to 1829 Luther Halsey was professor of natural philosophy, chemistry and natural history, and from 1830 to 1854 a similar position was held by John Torrey. In 1874 George Macloskie was appointed professor of natural history, and still occupies the chair of biology as professor emeritus. It was not until a few years ago, however, that one man, Professor Rankin, gave all his time to botany, and only very recently that Shull was appointed as the first professor of botany and genetics.

So far as shown by the actual dates given me, Columbia was the first institution where botany was taught, since Daniel Treadwell was professor of natural history at Kings College from 1757 to 1760. The first professor of botany was Richard Sharpe Kissam, 1792, who was succeeded by Samuel L. Mitchill, 1793 to 1795. After that botany was apparently included under natural history until the time of Dr. Torrey, who was professor of chemistry and botany, and apparently the real founder of the science at that institution.

According to both Farlow and Harshberger, the University of Pennsylvania can claim the first real botanical professorship in this country, as Dr. Adam Kuhn was made professor of botany and materia medica in 1768. Later William Bartram was appointed to the same chair, but did not accept.

Recent Development in Colleges.—Practically all this early instruction was limited to a systematic and a morphological study of the phanerogams. Apparently it had little or no relation to agriculture, its aim being purely scientific and educational, not practical. Modern botanical instruction, so far as a single institution can illustrate it, began at Harvard in the early 70's, when, under Gray, opportunity was provided for Goodale's work in vegetable physiology and Farlow's in cryptogamic botany.

About this time, however, the establishment of state universities and agricultural colleges formed a potent agency in the development of modern botanical education; for just as surely as these have been prime factors in the progress of modern agriculture, so have they been in the growth of modern botany, at least in its economic aspects. Among the names associated with this pioneer period are those of Farlow, whose early work at the Bussey Institution was of an agricultural nature, Beal, at the Michigan Agricultural College, Burrill, at the University of Illinois, Bessey, at the Iowa Agricultural College, and later at Nebraska University, Tracy, at the University of Missouri, Havey, at Maine, and a few others.

To-day there are approximately three hundred teachers and investigators carrying on this work in our agricultural colleges and stations; while there are perhaps an equal number engaged in botanical work in the universities outside of agricultural colleges, and in other non-agricultural institutions. These, with the four hundred in the Bureau of Plant Industry at Washington, make about one thousand persons in this country engaged in advanced botanical work as a profession.

In order to gain some idea of the number of general and special students in botany, and the courses offered in the agricultural colleges as compared with those in non-agricultural institutions (including those where botanical instruction in the university is separate from that in the agricultural college), the writer recently sent out a short questionnaire to an equal number of agricultural and non-agricultural institutions, and received replies from 41 of the

former and 38 of the latter. No doubt these questions were not always answered from the same point of view, but including such possible discrepancies, they show the following results:

Total attendance at reporting agricultural institutions, 62,049; non-agricultural, 70,000; an average number per institution of 1,513 and 1,842, respectively. Number of students taking some work in botany the past year, in the former 12,594, in the latter 6,354, or average numbers per institution of 307 and 167. This means that about 20 per cent. of the students in agricultural institutions took some form of botany as compared with 9 per cent. in the non-agricultural. Number of major students in botany, for the former 391, as compared with 386 for the latter, making an average per institution of 10 in each case. Number of postgraduate students doing botanical work in the agricultural colleges, 180, in the non-agricultural, 228, or an average per institution of 4 and 6, respectively. Total number of botanical courses offered, in the former 537, in the latter 336, or an average per institution of 13 and 9, respectively. Of the 41 agricultural colleges, 32 had one hundred or more students taking some work in botany, while of the 38 non-agricultural there were but 16 with this number. There were 26 of these agricultural colleges that offered 10 or more courses in botany, as compared with 14 non-agricultural; and there were 13 of the former that reported 5 or more postgraduate students as compared with 9 of the latter. In total number of postgraduate students in botany, however, the non-agricultural colleges led, due to the large number at the University of Chicago, which was responsible for 103 of the 228 reported.

Admitting that these figures, like figures in general, probably lie, still we believe that from them and the data that accompanied them certain general conclusions can be drawn, as follows: (1) That, per institution and as a whole, the number of undergraduates taking botany in our American universities and colleges is greatly in favor of the agricultural institutions. (2) That the number of students in the latter pursuing advanced and postgraduate work, however, is not any greater. (3) That the variety and number of courses offered considerably exceed that of the non-agricultural. (4) That there are a number of our non-agricultural universities that in equipment, instructional force, and courses given in the pure science of botany offer advantages equal to or better than those in the best of the agricultural institutions.

The reasons for the conditions indicated by these conclusions are: (1) That, because of its affiliation with agriculture, botany in some form is favored or required in many of the agricultural colleges; while in the non-agricultural it is generally optional, and in a number of the smaller eastern colleges is not even offered as a distinct course, being given only under "biology." The inclusion under botany of bacteriology, plant breeding and forestry, or the very close connection where these subjects have been split off from this science, and the more distant, but still distinct connection with agronomy, horticulture in all its lines and entomology, are secondary factors in furnishing in the agricultural colleges numerous students who must have some instruction in botany, and from widely different points of view, thus developing numerous courses. Finally, the chances of landing a botanical position, aside from those in high schools and the limited number in non-agricultural institutions, are greatly in favor of the man who has had at least undergraduate training in the agricultural college, since he has open to him the numerous places in these institutions, their experiment stations and

the Department of Agriculture; or if he merely takes minor work in botany, and specializes in some other line of agriculture, there are open the countless positions in these allied branches, including those of the newly established Farm Bureau work.

Department of Agriculture Botany.—Turning now from the botany in our agricultural colleges to that in the U. S. Department of Agriculture, what can we say of its development and influence? It apparently had its beginnings in the Patent Office Reports and the plant collections that were deposited with the Smithsonian Institution from time to time, chiefly by the various governmental exploring expeditions in the far west. As a distinct division, it was established soon after the completion of the department building in 1868, when it was found necessary to have a botanist to complete the working force, which at that time included among others a chemist and an entomologist.

C. C. Parry was apparently the first botanist, and he wrote in his report for 1869 as follows:

> In entering upon the duties of botanist to the Department of Agriculture in March, 1869, my first care was directed to the arrangement of the large and valuable collections of dried plants received from the Smithsonian Institute.

In April, 1872, George Vasey became the botanist, and, like Parry, his time at first was largely taken up with herbarium duties. Vasey, however, soon began to publish articles dealing with flowering plants, partly from a systematic point of view, though economic studies of the grasses, of weeds, and of medicinal and poisonous plants were also made.

Although as early as 1871 Thomas Taylor, the microscopist of the department, had written articles concerning various diseases of plants caused by fungi, and even such obscure troubles as peach yellows, it was not until 1886 that the Division of Botany established a distinct mycological section, with F. Lamson-Scribner in charge. The character of his report for this year forecasted the important place that this subject was to occupy in the future development of the department. That this new work met with the hearty approval of the country was shown by resolutions adopted by various societies and sent to the commissioner of agriculture, among which was one by the Botanical Club of America.

In 1888 B. T. Galloway was appointed chief of the Section of Vegetable Pathology and Physiology, and, with A. F. Woods as assistant, was intimately connected with its subsequent development. One of the most important of the results of the Galloway regime was the reorganizing in 1901 of all the divisions of the department dealing with plant life, save forestry alone, under the new Bureau of Plant Industry. These united divisions were those of botany, pathology and physiology, agronomy, pomology and the experiment gardens and grounds, and with these were later included the Arlington Experiment Farm and some other lines of work. So far as the writer knows, the Department of Agriculture is the only institution in the United States that has recognized botany in its broadest meaning, and kept under its wing all the practical branches that elsewhere assume entire independence, or even include botany as a part of their development.

To-day the Bureau of Plant Industry has on its staff over 400 investigators doing work in the 32 groups which are under its control. These groups include such varied investigations as fruit diseases, forest pathology, cotton and truck diseases, crop physiology, soil bacteriology, soil fertility, drugs and poisonous plants, grain standardization, cereals, corn, tobacco, agricultural technology, fiber plants, seed testing, forage

crops, economic and systematic botany, sugar beets, irrigation, horticulture and pomology, seed and plant introduction, etc.

One of the more recent duties of this Bureau in connection with that of entomology has been inspection work under the Federal Horticultural Law passed in 1912. This has to do with regulations, including quarantine, and inspections, to prevent the importation of injurious insects and diseases of foreign plants, and in certain cases, to limit the further spreading of those already here. Previous to this law such work had been largely restricted to local state inspection, having had its origin in the effort of certain states to limit the spread of the San José scale. This work has been, and still is, largely in the hands of the entomologists.

While botanists got a late start here, they seem to have been the chief factor in similar work in Europe, so that when a world's conference was recently called at Rome to consider the subject, it was termed a Phytopathological Congress. This nomenclature seems to have aroused certain American entomologists with fear that plant pathologists were running away with what they considered their special work. Howard voiced this sentiment a year ago in a paper before the entomologists, as follows:

> There is a tendency now to break into the solidarity of our branch of science and to unite us with the plant disease people under the term phytopathology in so far as insects affect plant life. . . . To combine them into one service would be impracticable except as work of a large agricultural institution. To combine them under one name in a branch of agricultural science is absurd!

Personally the writer believes this work is more botanical than entomological, since the hosts are plants and the pests also in part. However, the work is largely routine and semi-political, involving the passage of inspection laws and the asking for appropriations, and so is somewhat on a par with the fertilizer work of our chemical friends. Why not then allow the entomologists still to dominate in this work in America, as they seem eminently fitted for it, and thus allay their fears of being absorbed by the plant pathologists?

Experiment Station Botany.—Let us now consider briefly the third factor in our recent botanical development, namely, experiment station botany. In a sense this is Department of Agriculture botany locally applied. However, the station botanist is usually working on various botanical problems, while the government botanist is putting his whole time on a few allied problems. This becomes increasingly so as time goes on; therefore one may expect the station worker to be a somewhat broader botanist, and the government investigator more of a specialist. On the other hand, the latter often has a wide but limited knowledge of his problem over the whole country, while the former has a detailed and continuous experience in a limited region. Together these two types of investigators are able to furnish admirable solutions to most botanical problems.

To Arthur, apparently, belongs the honor of being the first station botanist, as he was botanist at the Geneva station in 1884, when he published, among other studies, his paper on pear blight; however, in 1883 Maynard, professor of botany and horticulture at the Massachusetts College, was head of the horticultural department of the Massachusetts station, and published some notes on plant diseases that year.

Most of the states, upon the establishment of their stations, merely employed the professor of botany already at work in the college, and we have mentioned the names of several. Others established botanical departments for the first time, or placed them on a more substantial footing, and to these there came sooner or later such men

as Halsted from Iowa to New Jersey, Thaxter to Connecticut, Atkinson to Alabama from South Carolina, Humphrey and later Stone, to Massachusetts, Chester to Delaware, Pammel to Iowa, Nelson to Wyoming, Bolley to North Dakota, Earl to Mississippi, Jones to Vermont, Selby to Ohio, Stewart to Geneva, N. Y., and Rolfs to Florida.

To-day the botanist is a fixture at practically all the stations. Naturally some stations have been more active than others along botanical lines, and these have, besides a chief botanist, several assistants, or the work is divided into botany, plant pathology and plant breeding. For example, there are listed a dozen such investigators at the California station, and Cornell has eleven who give all or part of their time to station work; while at the Ohio station there are seven who give all their time.

Naturally one expects the station botanist to be primarily an investigator. In practise, however, he is handicapped by various other duties that limit his time for investigation. Usually he has more or less teaching to do. Then such routine work as extensive local correspondence, field, orchard and nursery inspection, demonstration tests, institute talks, and aid to state agricultural societies of various kinds, adds to his duties.

Despite these limitations, the writer has in his possession some 1,700 bulletins and reports containing articles of more or less botanical interest published by station workers during the twenty-five years he has been interested in this work. From a purely scientific point of view most of these could have been omitted, but from an educational one they doubtless all have a reason for their existence. These articles, and an equally large number published by the botanists of the Department of Agriculture, lead me in conclusion to a consideration of the investigations in agricultural botany.

Investigations: (1) *Flowering Plants.*—These may be discussed under the three general headings of Flowering Plants, Bacteria and Fungi. Naturally enough, cultivated crops have attracted most attention, but much of this investigation, though semi-botanical in nature, has been made by the agronomists and horticulturists rather than by botanists. Considerable attention has been paid, especially in the past, to variety testing and to methods and time of seeding or propagating, cultivating and fertilizing, different crops, as affecting their growth in various localities.

Among the botanists who have worked along these agricultural and horticultural lines may be mentioned Bailey, with his numerous studies of a great variety of horticultural and ornamental plants; Earle, with his work with southern varieties of fruits and vegetables; Cook and Hume, with tropical plants; and others with special plants, as Mell with cotton, Carleton with wheat, Toumey with the date palm, Bolley with flax, Ball with sorghum, Stuart with potatoes, Selby with tobacco, R. S. Smith with English walnut. In this connection must be mentioned the plant introduction work carried on by the government under the direction of Fairchild and his assistants. Greenhouse problems have received attention from Bailey, Galloway and Stone.

Another line of work more purely botanical in nature was the floristic surveys made in several of the states, especially where the flora was not well known. Nelson's work on the flora of Wyoming has been perhaps as extensive and continuous as any of these. Others who have published station bulletins on the plants of their states are Earle and Mell of Alabama, Bolley and Waldron of North Dakota, Blank-

enship of Montana, Hillman of Nevada, Wooton of New Mexico and Bogue of Oklahoma.

Those who have made studies or tests of the trees and shrubs, both native and introduced, include Roberts of Kansas, Garman of Kentucky, Beal of Michigan, Green of Minnesota, Bessey of Nebraska, Halsted of New Jersey, Kennedy of Nevada, Wooton of New Mexico, Thornber of Washington, Murrill of New York, Burns and Jones (with his assistants), of Vermont, and Blakeslee of Connecticut.

Of course the government has done much work along these systematic lines, especially with the western flora, beginning with the publications of Vasey and continued by those of Coulter, Coville, Rose, Britton, Piper, and others. This work has now largely returned to its original home in the Smithsonian Institution, leaving only the more practical studies to the Department of Agriculture.

Starting with Vasey's economic work with the grasses, there have been many investigations to determine the most valuable hay, meadow and range grasses, and especially the conditions affecting the last. These have involved detailed studies of classification, distribution, habits of growth, environment, and chemical composition. Somewhat similar studies have been made with legumes and certain forage cacti. Among the investigators concerned with this work may be mentioned F. Lampson-Scribner, Hitchcock, Nelson, Pammel, Williams, Kennedy, Griffiths, Piper, Wooton, and Thornber.

Weeds, especially their identification, nature and methods of eradication, have been another means of keeping botanists busy, more especially in the earlier days. Particularly bad pests, such as the Canada and Russian thistles, tumbleweeds, mustards, couch grass and orange hawkweed, have received especial study. General and special consideration of the weed problem early received attention from Dewey of the department, Millspaugh of West Virginia, Halsted of New Jersey, and Harvey of Maine. Special articles on particular weeds or lists of weeds in their respective states, have been published by botanists too numerous to mention. At first attempts were made to have laws passed regulating weed pests, but there has been little activity along this line in recent years, and such laws as exist are rarely enforced.

Seed testing has also had its share of attention from the station and government botanists. This work has included methods of identification, kinds of impurities and adulteration, and tests for germination. Laws have been enacted in several of the states relating to the sale and testing of seeds. The work, while important, has never received quite the detailed attention here that has been given to it in some of the European countries. Besides the publications of the Department of Agriculture, numerous others have been issued by the stations at Maine, Connecticut, North Carolina, New York, Kentucky, Ohio, Michigan, Iowa, Nebraska, North Dakota, and some other states.

Poisonous plants have claimed especial care from Chestnut, Wilcox and Pammel, with contributions from such others as Blankenship, Bessey and Halsted. Drug plants have been dealt with by True and his associates.

Physiological and chemical studies of plants have not had so much attention from botanists as some other lines of investigation, yet good work has been accomplished by Loew, Swingle, True, Alsberg, Kearney, Briggs, Schantz, and others of the department. Much of this work relates to soil moisture and soil solutions both favorable and detrimental to plant growth. Various

station workers, as Stone, Duggar and Reed, have made investigations dealing with special problems involving physiological and chemical study. Through the cooperation of the botanists with the chemists, the general chemical composition of many plants, especially grasses, has been determined.

Plant breeding is one of the most recent lines of work that has been taken up by several of the stations. This in reality is not so new as it may seem, for various horticulturists and agriculturists, as Sturtevant with corn, Munson with fruits, McClure with sweet corn, and Hayes with wheat, and such botanists as Halsted with vegetables, Webber with citrous fruits, and Carleton with cereals, had long been interested, as shown by their publications. Recent work, however, has aroused new interest, and we may merely mention in passing that of Smith, East, Shull and Hartley with corn, Selby, Shamel, East and Hayes with tobacco, Roberts with wheat, McLendon with cotton, Groth with vegetables, Emerson and Belling with beans, Webber and Clark with timothy, Hansen with fruits, and Love with oats. Some of these investigations have aimed to solve the laws that underlie plant breeding, and others chiefly to produce more valuable strains or increased yields of the plants investigated.

(2) *Bacteria.*—Coming to bacteriological investigations, we find that, on the whole, our botanists have not taken so prominent a part in the work. This is because bacteriology as now constituted, though it deals with plants, is considered a distinct science. So, with the exception of teaching, in part, and investigations of plant diseases, bacteriology has passed mostly outside the realm of botany. In fact, as regards general sanitation and the bacterial diseases of man and animals, our botanists have never done much work. Burrill has always been interested in these lines, and one of his students, Briscoe, published bulletins on the tubercle bacillus. Chester, like Burrill, did a little work with animal diseases, and several botanists have published popular articles.

Dairy bacteriology also has remained largely a subject for specialists outside of the botanical realm, though such biologists as Conn, Russell and Marshal have done good work.

Soil bacteriology, however, has come a little closer home, and has occupied the attention of Chester, Kellerman, and a few others, while Burrill, Schneider, Moore, Kellerman, Duggar, Harding and Garman have been interested in the question of the bacteria of root tubercles on legumes.

Coming to the work with plant diseases, however, we find the botanists of this country have accomplished more in this line than all the rest of the world. To start with, Burrill was the first to prove that bacteria cause disease in plants; and, in the development of this line of work, Smith of the Department of Agriculture has accomplished results that place his name high among American botanists.

Among the many who have published articles dealing with special bacterial diseases of plants may be mentioned those of Burrill, Arthur, Waite, and Whetzel on pear blight, of Thaxter, Bolley and Lutman, on potato scab, of Smith, Townsend, Hedgcock, and C. O. Smith on crown gall, of Pammel and Smith on black rot of cruciferous plants, of C. O. Smith on walnut blight, of Jones on bacillus of carrots, of Stewart on the corn disease, of Stevens on tobacco wilt, of Manns on the oat disease, of Giddings on the rot of melons, and of Johnson on the coconut bud rot.

(3) *Fungi, etc.*—Taking up the last line of investigations, those with the fungi, one finds himself overwhelmed with the amount

of good work that has been done. If the American botanist leads in any kind of investigation, it certainly is in the study and treatment of plant diseases. One of the earliest lines of work was listing the species of fungi that were found in the different states, such lists, often descriptive, being published by Burrill for Illinois, Atkinson and Earle for Alabama, Tracy and Earle for Mississippi, Williams for South Dakota, Jennings for Texas, and Jones and Orton for Vermont.

Many botanists have made similar surveys for the destructive fungi of their economic plants, as Halsted for New Jersey, Pammel for Iowa, Selby for Ohio and Stewart for New York. Sturgis, and Stevens with his students, have been concerned with the literature of plant diseases; and Atkinson, Duggar, Freeman and Stevens have published books dealing with fungi. Farlow, Atkinson, Duggar, and some others have contributed data concerning edible and poisonous mushrooms. Von Schrenk, Hedgcock, Spaulding, Metcalf, Heald, Graves and Long have made studies of the diseases of trees and the decay of timber. Thaxter, Rolfs, Fawcett and Speare have been interested in the fungous diseases of injurious insects.

Determination of the alternate stages of fungi has been an entrancing study for those engaged in it, and special mention should be made of such work with the rusts by Arthur, Kern, Olive and others of Arthur's students. Artificial culture of fungi commenced with the early work of Thaxter and Atkinson, and now plays an important part in all mycological investigations, those of Shear, Heald and Edgerton well illustrating this type of work.

Disease resistance to specific fungi has received attention from Orton, with cotton and watermelons, Carleton and Freeman with cereals, Bolley with wheat and flax, Stuart with potatoes, Norton with asparagus, and Blinn with muskmelons.

In addition to the preceding, many studies have been made of physical injuries and so-called physiological diseases of plants. Prominent among such studies are those of Smith with peach yellows and rosette, Atkinson with edema troubles, and Woods, Allard and Chapman with calico of tobacco. Stone has contributed to our knowledge of injury by electricity; Sturgis, Bain and many others, of spray injury. Winter injury has received especial attention from Waite, Selby, Grossenbacher, Morse and others.

One of the most practical lines of work has been the so-called "squirt-gun botany," which deals with the treatment of plant diseases by spraying. Among the early investigators working along this line should be mentioned Goff with apple scale, Lamson-Scribner with grape rots, Thaxter with quince leaf-blight, Jones with potato blight, Chester with brown rot of peach, Lodeman with fruit diseases, and Galloway, Halsted, Stewart and Selby with a great variety of diseases.

As Bordeaux mixture is one of the oldest and most frequently used of the fungicides, it has received especial attention as to its composition, action, etc., in articles by Chester, Fairchild, Crandall and Lutman. In recent years lime-sulphur, borrowed from the entomologists, and first used as a fungicide in the west by Pierce and others, has been brought into prominence in the east by the work of Scott of the Department of Agriculture, and by various station botanists. The development of the self-boiled lime-sulphur by Scott is a still more recent factor in spraying.

Hot water treatment for smuts of grain first received attention in this country from Kellerman and Swingle, while Bolley and later Arthur brought forth formalin for

a similar purpose; and Thaxter, the use of sulphur for onion smut. To Bolley we are chiefly indebted for the use of corrosive sublimate and formalin solution as remedies for potato scab, while Morse has used the fumes of formalin as a substitute.

Our pathologists seem to have been in their prime, however, when making detailed life history studies of economic fungi. The particular foes of each cultivated plant have received attention, though naturally those that are most common and destructive have had special consideration. If time permitted we should like to mention these more specifically. Each of our numerous mycologists has contributed his part to the work. Some few of these investigators have already passed to the great beyond, and others are gradually laying aside the work; many, however, are yet in their prime, while there are still more just coming into prominence. Of the last I would say that their standard of work is as high, if not higher, and their training better, than that of the older investigators, though the opportunities for original work grow less or more difficult with each year. Perhaps, however, I am mistaken, and it is only the nature of the work that changes, as indicated in letters to the writer from the late M. C. Cooke of England, who, with Ellis and Peck of this country, though not directly connected with agricultural botany, has greatly helped it by systematic work with the fungi. In conclusion permit me to quote these friendly sentiments of Cooke:

> For the past forty years and more I have had kindly correspondence and good feeling with botanists in the states, some of whom I claim as my pupils in mycology. From the time of Asa Gray, one of my first friends, I have had many. Half a century has passed me in the study of fungi, and I find as much still to learn, but I am too old now to do more than float over the surface, and confine myself to plant diseases. I note with great gratification the immense development of this branch of study on your side, which puts us to shame. Your experiment stations are fine institutions. . . . I care not who does the work, only I am delighted to see it is being done, and, between ourselves, to realize that it is being done by an English-speaking race and not by Germans or Frenchmen. To my American brethren, the mycologists, I am wishing God speed, and I care not how they beat us so long as they keep it up on a high level, clear of empiricism and worthy of the race.

G. P. CLINTON
CONNECTICUT AGRICULTURAL EXPERIMENT STATION

THE MINERAL PRODUCTION OF THE UNITED STATES IN 1915

THE midyear review of mining conditions reported to the Secretary of the Interior on July 1 by the Director of the United States Geological Survey is well supported by the preliminary reports for the year. The Geological Survey is making public its usual estimate of mineral production for 1915 in the form of a separate statement for each of the more important mineral products.

A review of these statements confirms Secretary Lane's comment of last July to the effect that the mining revival is in full swing. In the western states alone the metal production shows an increase in value of more than $130,000,000 over the corresponding figures for 1914; and the year's increase in output for the principal metals measured in value is more than $250,000,000. Moreover it is not unreasonable to expect that when the full returns for all mineral products are compiled they will show that 1915 was the country's most productive year in the mining industry. The total may even reach two and one half billion dollars.

In the response to bettered conditions the production figures for copper, iron and zinc show the largest increase.

The copper mines passed all records for previous years, the 1915 output having a value of $236,000,000, or $83,000,000 more than the value of the production for 1914. The statistics and estimates received place the output of blister and Lake copper at 1,365,500,000 pounds or more than 120,000,000 pounds in excess of

the largest previous production and eighteen per cent. above last year's figures. Only twice in the history of copper mining has there been a larger increase in quantity of metal produced.

The total shipments of iron ore from the mines in the United States in 1915 are estimated to have exceeded 55,000,000 gross tons, an increase over 1914 of more than 38 per cent. Based on the same price as received in 1914 this represents an increase in total value of about $27,645,000. The increase in pig iron is estimated at 6,500,000 tons, with a total increase in value of pig iron production of more than $120,000,000.

The output of zinc (spelter) made from domestic ores was larger than ever before, being about 425,000 tons, worth $120,000,000 as compared with 343,418 tons in 1914, an increase of about 82,000 tons or nearly 25 per cent. in quantity and of $85,000,000 in value. Production was increased during the latter half of the year, as the production during the first half was at the rate of 415,000 tons annually and at the rate of 436,000 tons during the last half.

The output of refined pig lead from domestic ores was about 515,000 tons, worth about $48,500,000 as compared with 512,794 tons in 1914, an increase of only 2,500 tons in quantity but of $8,500,000 or 20 per cent. in value. The production of antimonial lead was 20,550 tons as compared with 16,668 tons in 1914, an increase of 3,882 tons or 23 per cent. in quantity and an increase in value of nearly $2,000,000.

The annual preliminary estimates on the production of gold and silver in the United States, made jointly by the United States Geological Survey and the Bureau of the Mint, are not yet complete, but early figures based on reports from the mines indicate an increase in mine production over that of 1914 of over $7,000,000 in gold, principally from Colorado, California, Alaska, Montana and Idaho, and an increase in mine production of silver of fully 4,000,000 ounces, chiefly from Montana, Utah and Arizona. This increase in gold production may bring 1915 up to the record year of 1909, when the gold output of this country was nearly $100,000,000.

Quicksilver also has had its best year in 1915. The quantity increased 25 per cent. over 1914, but the value of the output more than doubled owing to the much higher prices. The estimated production was 20,681 flasks of 75 pounds each, valued, at the average price for the year—the highest in the last forty years—at $1,768,225. In value, this domestic production was the highest since 1881 and in quantity the largest since 1912.

The production of bituminous coal and anthracite in 1915 is estimated to have increased between four and five million short tons, or less than 1 per cent. The quantity of bituminous coal mined increased about 6½ million tons and that of anthracite decreased over two million short tons. Owing mainly to steady demands for export coal and for coke for steel making, the output in Pennsylvania, West Virginia, Kentucky and Alabama increased over last year, but little change is recorded in other eastern states. The region west of Ohio, including the Mississippi Valley, shows a general decrease, Colorado being the only western state to show betterment.

Connected with the coke industry was the completion during the last summer of a number of large plants for the recovery of benzol from by-product coke-oven gas. This gives the United States its first output of this material, so important as a raw material in the manufacture of high explosives and chemical dyes, and the amount of this product will be reported later.

Preliminary estimates of the total output of petroleum in the United States in 1915 indicate a slight increase over the corresponding output in 1914. It is believed that the total petroleum yield of the United States in 1915 amounted to 291,400,000 barrels, of which quantity it is also estimated that 267,400,000 barrels was marketed and 24,000,000 barrels placed in producers' field tankage during the year.

The sulphuric acid industry in 1915 presented interesting development. In spite of the abnormal demand and higher prices in the latter half of the year, much of the sulphuric acid had been contracted for or was con-

sumed in the factories where made. The estimated production indicates an increase of 6½ per cent. in the three common grades, but more than 100 per cent. in the strongest grades.

The estimate of Portland cement output in 1915 indicates shipments from the mills of 86,524,500 barrels, an increase of one tenth of one per cent. over 1914. There was a slight decrease in production and this, with the appreciable decrease in stock, indicates a more conservative trend in the industry, which in the preceding few years showed a tendency to overproduction. Prices generally averaged a few cents lower per barrel in 1915 than in 1914, although toward the end of the year prices were substantially increased, and the outlook for 1916 is brighter than for several seasons.

Perhaps the most notable item in the year's record is the stimulation of metal mining in the western states. Almost without exception the increases in production were large and in several states 1915 was the best year on record. In Arizona, which leads in copper, the output of that metal exceeded the previous record production of 1913. California continues to lead in gold and had the largest yield in thirty-two years, and with one exception in half a century. In Montana and Arizona record outputs of silver are reported and in Alaska the increased production of gold and especially copper made 1915 a much more prosperous year than even 1906 when Fairbanks and Nome were yielding their greatest returns of gold from bonanza placers.

MEDALISTS OF THE ROYAL SOCIETY

AT the anniversary meeting of the Royal Society on November 30, the president, Sir William Crookes, characterized the work of those on whom the medals of the society had been conferred as follows:

The Copley medal has been conferred upon Professor Ivan Petrovitch Pavlov, one of our most distinguished foreign members, whose researches in physiology have led to the acquisition of valuable knowledge. By a most ingeniously worked-out and original method of making fistulæ or openings to the exterior, Professor Pavlov has successfully studied the interrelation of the functions of the alimentary canal. His experiments have shown how the presence of food in one cavity controls the secretion of digestive juices into the next, and he has made many discoveries concerning the conditions which influence the secretory process, while his method has facilitated the study of the chemical changes which occur in the food as it passes through the canal. Moreover, by the method which he calls that of conditioned reflexes, Professor Pavlov has studied, from a physiological point of view, the influence of the higher brain centers upon the secretion of saliva. He has also investigated the mechanism of the muscle by which bivalves open and close their shells, and the nervous control of the heart, especially through the sympathetic nerves. His resourcefulness and skill have enabled him to make important contributions to physiological science, and his work, the true worth of which has, perhaps, not yet been rightly prized, deserves the fullest recognition.

The Royal medal given annually for physical investigations has been awarded to Sir Joseph Larmor, whose work in mathematics and physics includes a very wide range of subjects—geometry, dynamics, optics, electricity, the kinetic theory of gases, the theory of radiation and dynamical astronomy—upon all of which he has published illuminating memoirs. Possibly his chief claim to distinction is the establishment of the theory that radiant energy and intramolecular forces are due to the movements of minute electric charges. This theory is fully worked out in his treatise, "Æther and Matter." For a long time Sir Joseph Larmor acted as secretary to the Royal Society, performing the duties of the office with great success, at the same time continuing with unabated vigor original research. The offer of the Royal medal is a mark of the society's appreciation and admiration of his invaluable services to science.

The other Royal medal, for work in the biological sciences, is this year conferred upon Dr. William Halse Rivers Rivers, whose work in ethnology has contributed largely to the establishment of the subject upon a scientific basis. He was the first to use the genealogical method in ethnological investigations. His remarkable originality, combined with sound judgment, have enabled him to produce work which will rank with the best that has been done in ethnology.

All chemists will agree that the award of the Davy medal to Professor Paul Sabatier is fully justified. His lengthy researches on the use of finely divided metals as catalysts are universally known. The hydrogenation of unsaturated or-

ganic compounds, especially by means of nickel, has been thoroughly elucidated by Professor Sabatier and his coworker, the Abbé Senderens. The industrial application of the process to the unsaturated acids of the oleic series has already acquired considerable industrial importance. It gives me great pleasure to announce the award, so well earned by Professor Sabatier.

The Hughes medal is awarded to Professor Paul Lanvegin, who has made valuable contributions to electrical science, both on the theoretical and experimental sides. He has found by experiment the rate of recombination and the mobility of ions produced by different processes in gases at various pressures, and he has made an exhaustive study of the theoretical aspects of the interdiffusion of gases and the mobility of ions.

MEMORIAL TO JOHN WESLEY POWELL

The Department of the Interior has completed, on the rim of the Grand Canyon, in Arizona, a memorial to Major John Wesley Powell, the pioneer and distinguished man of science who first explored the Grand Canyon. The memorial is an altar decorated in Indian imagery and supporting a bronze tablet, resting upon a pyramidal base of rough-hewn stone. Fifteen steps lead from the west up to the altar floor, from which one may gaze into the very heart of the glowing mile-deep canyon. It is a structure worthy alike of the rugged, forceful personality of the man and of the titanic chasm which it overlooks.

The spot chosen for the memorial is Sentinel Point, a promontory south of the railway station, which commands a particularly fine view of the Granite Gorge and of the river, whose unknown terrors of whirlpool and cataract the Powell party braved in small open boats. The structure, which is built of weathered limestone from the neighborhood, has a rectangular base 21 by 28 feet. The altar carries on its east side a medallion portrait of Major Powell in bronze bas-relief by Leila Usher and the following inscription:

> Erected by the congress of the United States to Maj. John Wesley Powell, first explorer of the Grand Canyon, who descended the river with his party in rowboats, traversing the gorge beneath this point August 17, 1869, and again September 1, 1872.

The general effect is unobtrusive, natural and appropriate. A few small, gnarled trees grow close by, but do not obstruct the view. The structure stands back from the edge sufficiently to permit visitors in considerable numbers to group themselves in front.

The memorial was planned at the International Geological Congress of 1904 in recognition of Major Powell's distinguished services as director of the United States Geological Survey. In March, 1909, Congress appropriated $5,000 for the purpose, "in recognition of his distinguished public service as a soldier, explorer and administrator of government scientific work." Dr. H. W. Holmes chose the site.

The original plan was to make the memorial a Roman chair facing the canyon. Last spring Secretary Lane substituted an altar for the chair, and Mark Daniels, then general superintendent and landscape engineer of National Parks, designed the structure as it stands to-day.

It was then late in July, and Mr. Walter Ward, engineer of the Reclamation Service, had a difficult task before him to find and hew the rock and build the structure within the slender appropriation.

This memorial, so expressive of the spirit and character of the man whose life work it celebrates, and so admirably located, will be formally dedicated early next summer. If, as is expected, Congress meantime makes the Grand Canyon a national park (it is a national monument now), the two dedications will take place together, making a celebration altogether notable in the history of national parks.

SCIENTIFIC NOTES AND NEWS

Dr. Charles R. Van Hise, president of the University of Wisconsin and previously professor of geology, has been elected president of the American Association for the Advancement of Science, in succession to Dr. W. W. Campbell. The other officers elected at the Columbus meeting of the association and an account of the proceedings will be found elsewhere in the present issue of Science.

DR. JOHN M. CLARKE, New York state geologist and director of the State Museum, was elected president of the Geological Society of America at the recent Washington meeting.

DR. RAYMOND DODGE, professor of psychology at Wesleyan University, has been elected president of the American Psychological Association.

OFFICERS were elected at the New Haven meeting of the American Association of Anatomists as follows: *President,* Dr. Henry H. Donaldson, Wistar Institute; *Vice-president,* Professor Clarence M. Jackson, University of Minnesota; *Members of the Executive Committee,* Professor Eliot R. Clark, University of Missouri, and Professor Reuben M. Strong, University of Mississippi. Professor C. R. Stockard, Cornell Medical School, New York City, remains secretary of the Association.

OFFICERS of the Elisha Mitchell Scientific Society, Chapel Hill, N. C., for the year 1916 are as follows: *President,* Dr. J. B. Bullitt; *Vice-president,* Professor T. F. Hickerson; *Permanent Secretary,* Dr. F. P. Venable; *Recording Secretary and Treasurer,* John E. Smith; *Editorial Board of the Journal:* Dr. W. C. Coker, Professor Collier Cobb and Dean M. H. Stacy.

AT the annual dinner of the Geographic Society of Chicago, the gold medal of the society was presented to Major-General William C. Gorgas. The presentation address was made by Dr. Frank Billings. General Gorgas gave an address, entitled "Sanitation in Its Relation to Geography."

WE learn from the *Journal* of the American Medical Association that the Royal College of Physicians of London has awarded the Moxon gold medal to Dr. Dejerine, professor of diseases of the nervous system at the Faculté de médecine de Paris. This medal is awarded every three years to the scientist whose observations and researches in clinical medicine are deemed to render him most worthy of this distinction. The award of the medal is not reserved for scientists of British nationality, but up to the present it has been given only to English clinicians; Sir Alfred Garrod (1891), Sir William Jenner (1894), Sir Samuel Wilkes (1897), William Tennant Gairdner (1900), John Hughlings Jackson (1903), Jonathan Hutchinson (1906), Sir William Richard Garvers (1909), Sir William David Ferrier (1912).

THE *British Medical Journal* states that the Leeuwenhoek gold medal of the Royal Academy of Sciences, Amsterdam, has been awarded to Surgeon-General Sir David Bruce. It is awarded every ten years in recognition of the most important work done during the decade on the microscopical organisms first discovered by Leeuwenhoek in 1675. The award sets out that it was the discovery of the *Micrococcus melitensis,* the cause of Malta or Mediterranean fever, which first made Bruce's name generally known. This was followed by the discovery of the cause of African cattle, or tsetse fly disease, known as Nagana. Afterwards he made extensive researches, with the help of a staff of assistants, into other tropical African diseases caused by trypanosomes, especially into sleeping or Congo sickness caused by the *Trypanosoma gambiense* and transported chiefly by the fly *Glossina palpalis.* The medal was presented at the meeting of the Academy of Sciences in Amsterdam on December 18.

SIR W. H. SOLOMON and Professor G. H. Bryan have been elected to honorary fellowships at Peterhouse, Cambridge.

MR. GEORGE L. FAWCETT, from 1908 until last February the plant pathologist at the Porto Rico Experiment Station at Mayaguez, and since that time occupying a similar position at the Experiment Station in Tucuman, Argentina, has been appointed professor of mycology and bacteriology at the University of Tucuman.

DR. WILLIAM H. WELCH, professor of pathology in the Johns Hopkins Medical School, who has been in China devising plans to introduce modern medical methods in the empire, and Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, reached San Francisco on December 27.

Dr. Frank Angell, professor of psychology in Stanford University, has sailed for England to take part in Belgian relief work.

Professor Joseph M. Flint, of the Yale Medical School, has returned to New Haven after five months of work among wounded soldiers in the hospital at Chateau de Passy in France.

Dr. John F. Anderson, formerly director of the Hygienic Laboratory, United States Public Health Service, and now director of the research and biological laboratories of E. R. Squibb & Sons, New Brunswick, New Jersey, has sailed for England and France to study the methods in use in the armies of those countries for the prevention and treatment of wound infections.

Professor Jacques Loeb, of the Rockefeller Institution for Medical Research, delivered an address on "Adaptation" at the meeting of the Philadelphia County Medical Society on December 8, which was followed by a reception and supper. The meeting was arranged by the committee of the medical society on cooperation among allied agencies and institutions.

Dr. Alexander C. Abbott, professor of hygiene and bacteriology, the University of Pennsylvania, delivered an illustrated lecture on "The Transmissibility of Diseases and the Public Health" at Franklin Institute on the evening of December 15.

Dr. Henry E. Crampton, of Columbia University and the American Museum, delivered the oration before the Phi Beta Kappa Association of the University of Pennsylvania on December 4. Dr. Crampton took for his subject "Science, Culture and Human Duty."

Professor Edward Kasner, of Columbia University, spoke on "Some Unsolved Mathematical Problems" at the College of the City of New York on December 16.

The Herbert Spencer Lecture at Oxford University for 1916 will be delivered by Professor J. Mark Baldwin. The subject of the lecture is not yet announced.

The Croonian Lecture of the Royal Society was delivered on December 9, by Dr. W. M. Fletcher and Professor F. G. Hopkins, on "The Respiratory Process in Muscle, and the Nature of Muscular Motion."

A bronze portrait plaque has been placed in the Evans Dental Institute, to the memory of W. D. Miller, a graduate of the Dental School of the University of Pennsylvania, class of 1879. The plaque is the gift of the International Dental Federation. At the annual convention held in Berlin in 1909, a resolution was passed to present a bronze memorial plaque to the Dental School of the University of Pennsylvania, dedicated to one of its most distinguished graduates, W. D. Miller, who was a distinguished scientific man and one of the most eminent men in his profession.

Daniel Girard Elliot, distinguished for his contributions to mammalogy and ornithology, died at his home in New York City, on December 24, aged eighty-one years.

David Williams Cheever, emeritus professor of surgery in the Harvard Medical School, died at his home in Boston, on December 27, in the eighty-fifth year of his age.

Dr. James Holms Pollok, for many years on the staff of the Royal College of Science for Ireland, in the chemical department of which he was lecturer on physical and metallurgical chemistry, died on November 26.

Mr. C. J. Wollaston, known for his pioneer work in submarine telegraphy, has died at ninety-five years of age.

The death is announced of Charles René Zeiller, a member of the French Institute, chief engineer of mines and professor of paleobotany in the Paris School of Mines.

Adolphe Greiner, director-general of the foremost steelworks in Belgium, this year president of the Iron and Steel Institute, died at his residence near Liège on November 20, aged seventy-three years.

The United States Civil Service Commission announces an open competitive examination for fish pathologist in the Bureau of Fisheries on January 19, 1916. The duties of the fish pathologist are primarily to investigate the causes, the nature and the effects of

disease of fish or shellfish, physiological or environmental conditions associated with the development of pathological phenomena, and the means of prevention or cure. The investigation of stream pollution is involved, as well as the study of the physical, chemical and biological conditions that may be salutary or deleterious to fish. Competitors will be examined in general biology, physiologic chemistry and parasitology, with particular reference to aquatic animals. Credit will be given for thesis and manuscript or published reports. Graduation with a bachelor's degree from a course in a college or university of recognized standing and, in addition at least two years of postgraduate work, or the equivalent, in chemistry or biology are prerequisites for consideration for this position. The salary is $2,500 per annum.

THE Weather Bureau asks for an appropriation of $30,000 for extending the Carribean weather observations with a view to a system of communication of "considerable value in connection with the military and naval operations in the canal zone." Instead of observations once a day during a seven months' period at an inadequate number of stations, a continuous all-year-round service would be established at additional stations in South and Central America and along the southern gulf coast. A $25,000 structure on the canal zone to serve as the official headquarters for the weather service in that section also is planned.

THE equipment of the department of entomology at the University of Illinois, and of the natural history survey of that state, receives a notable addition in the new vivarium building in Champaign, which will contain a large insectary for student use, with three laboratory rooms in connection, an apparatus, furnished conjointly by the university and the State Laboratory of Natural History, for temperature and humidity control in the study of insect life histories, and a set of experimental aquaria fitted up for exact studies on the ecology of fresh-water animals. The insectary and entomological laboratories will be under the charge of Dr. R. D. Glasgow, and the state laboratory equipment under that of Dr. V. E. Shelford, of the laboratory staff.

THE *Journal* of the American Medical Association says: "On last Monday, December 20, the Supreme Court of Illinois rendered a ruling—it was not a decision, as the newspapers stated, but simply a ruling—in the case of Lydston *vs.* the State's Attorney. The newspapers, in sweeping statements—inspired?—have carried the impression that the ruling is against the American Medical Association; that the officers, including trustees, are holding their offices illegally; that a new election must be held immediately, etc. Nothing could be farther from the truth. It is the old story; it is merely another step in the case started about the time of the meeting of the American Medical Association in St. Louis in 1910, at which time Lydston tried to compel the state's attorney to bring *quo warranto* proceedings against the association. The American Medical Association has not yet technically been brought into the case; thus far the issue has been between Lydston and the state's attorney. The technical announcement of the ruling just made is "Hoyne, State's Attorney *vs.* People ex rel; Lydston; petition certiorari denied." The state's attorney tried to get a decision from the Supreme Court, but the Supreme Court declined to hear the case at this time and therefore denied the writ of certiorari.

ACCORDING to a press dispatch proposed legislation to create a government bureau of volcano observation is under consideration. The project, as outlined to congressional leaders by T. A. Jagger, of the Massachusetts Institute of Technology, a delegate to the Pan-American Scientific Congress, contemplates the securing of information on which ultimately predictions of volcanic disturbances may be based as well as studies of gases and liquids in the earth which may prove of value in connection with weather observations. There are said to be between four hundred and five hundred living volcanoes in the world, about one fourth of which are within United States territory, in Alaska, Hawaii and the Philippines.

The fifth annual meeting of the Oklahoma Academy of Science was held at Oklahoma City, Oklahoma, November 26 and 27, 1915. Thirty-five papers, dealing with various phases of biology, physics, chemistry and geology were presented. The address by the retiring president, Mr. Chas. W. Shannon, director of the Oklahoma Geological Survey, dealt with the work of the Oklahoma Academy of Science and its connection with the scientific work of the state. The following officers were elected for the ensuing year:

President, Chas. N. Gould, Oklahoma City.
First Vice-president, L. Chas. Raiford, Stillwater.
Second Vice-president, L. B. Nice, Norman.
Secretary, G. K. Stanton, Enid.
Assistant Secretary, Ethel L. McCafferty, Enid.
Treasurer, H. H. Lane, Norman.
Curator, Fritz Aurin, Norman.

The next meeting of the academy will be held in November, 1916, at the time and place of the meeting of the Oklahoma State Teachers' Association.

The Stanford University Medical School announces the thirty-fourth course of Popular Medical Lectures to be given in Lane Hall on alternate Friday evenings as follows:

January 14. "Medical Research and Its Relation to General Medicine," by Dr. George H. Whipple, director of the Hooper Foundation for Medical Research.

January 28. "The Economic Aspect of Disease," by Murray S. Wildman, Ph.D., professor of economics.

February 11. "Disease Carriers," by Dr. W A. Sawyer, secretary, California State Board of Health.

February 25. "The Relation of Hospitals to the Community," by Dr. George B. Somers.

March 10. "Locomotion in Health and Disease," by Dr. Walter F. Schaller.

March 24. "Mental Hygiene," by Lilien J. Martin, Ph.D., professor of psychology.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Miss Rose Hollingsworth, of Boston, the Massachusetts Institute of Technology, Radcliffe College, Mount Holyoke College and the Tuskegee Industrial Institute each receive $5,000. Five hundred dollars are bequeathed to the Gray Herbarium, the National Association of Audubon Societies, the Society for the Protection of Native Plants, the American Forestry Association and to the Massachusetts Forestry Association.

A gift of $75,000 has been announced to the Harvard Medical School. This is the balance of the bequest of Morrill Wyman, who established the Morrill Wyman Medical Research Fund, the income of which is to be applied in promoting investigation concerning the origin, results, prevention and treatment of disease.

The executors of the estate of the late Lord Strathcona have notified Queen's University, Kingston, that the $100,000 left to that university is now available and ready to be paid.

A valuable collection of periodicals, monographs and other medical books, consisting of more than 4,000 volumes, has been presented to the Johns Hopkins Hospital by Dr. Howard A. Kelly.

Professor Henry A. Perkins, of the department of physics, is acting president of Trinity College during the absence of President Luther.

DISCUSSION AND CORRESPONDENCE

THE ORIGIN OF THE "NITER SPOTS" IN CERTAIN WESTERN SOILS[1]

In a recent issue of Science, under the above title, Sackett and Isham[1] discussed this important question but conveyed no actual information regarding either the meaning of the term "niter spot" or its origin. They merely select for discussion a single point out of the great mass of available material so that the general scientific reader to whom an appeal is thus made through the columns of Science is left in doubt as to what it is all about. In order to clarify the matter for the average reader, it seems advisable to submit some definite information on the subject in

1 Sackett and Isham, Science, Vol. XLII., p. 452, October 1, 1915.

order that those who are not familiar with the data in the technical publications may form an intelligent opinion regarding the merits of the several theories proposed regarding the origin of these spots.

The term "niter spots" has recently been applied by Headden[2] to alkali accumulations in certain western soils which develop spots of a dark brown color. Formerly alkali soils were classified as white and black alkali, depending upon the presence or absence of color. The black color of the black alkali spots is due, as shown by Hilgard, to the presence of sodium carbonate, which has a solvent and decomposing action upon the organic matter in the soil. The white alkali consisting largely of the sulphate and chloride of sodium, having no solvent and decomposing action on the organic matter, does not produce any color. There is also an intermediate condition where the color of the alkali spot is a dark or light brown. In these so-called "niter spots" there are two main points which differentiate them from either the white or black alkali soils: (1) the accumulation of large quantities of nitrates; (2) the presence of a brown instead of a black color. The soil of these spots always contains large quantities of the sulphates and chlorides of sodium, potassium, magnesium and calcium. A discussion has arisen regarding the source of the nitrates and color of these special alkali spots.

Three theories have been presented regarding the origin of the nitrates in these spots. (1) Hilgard,[3] who first observed the accumulations of nitrates in certain alkali spots in arid soils, attributed them to the more rapid nitrification of the organic matter in the warm arid soils when the moisture factor was removed by the application of irrigation water. (2) Headden[4] believes them to be due to the fixation of atmospheric nitrogen by the non-symbiotic bacteria, notwithstanding the fact that these bacteria have no power to produce nitrates. Sackett,[5] apparently, adopts both the above views. He evidently assumes that the nitrogen is fixed by azotobacter or other non-symbiotic organisms and later nitrified by the nitrifying organisms. (3) Stewart and Greaves,[6] and later Stewart and Peterson,[7] believe the nitrates are due to the leaching and concentrating action of the irrigating water upon the nitrates occurring in the shales and sandstones (or country rock) adjacent to and underneath the affected areas from which the soil has been derived.

It is imperative to obtain a clear conception regarding the origin of these accumulations for two important reasons: (1) Considerable valuable land is being rendered non-productive, due to these enormous accumulations, and methods of reclamation must await proper conception regarding their origin. If the nitrate accumulations are the result of the concentration of the salts preexisting in the country rock proper methods of drainage, adapted to the peculiar soil formation will be effective in reclamation of the soil of the affected area. On the other hand, if the accumulations are due to the abnormal activity of the non-symbiotic bacteria, drainage is not only not effective in the reclamation of these lands but actually detrimental, since it makes more favorable the conditions for such bacterial activity. If the later conception is true, investigations must be undertaken to devise methods for checking the abnormal activity of the non-symbiotic bacteria. (2) Dr. Hopkins says:

> To increase or maintain the nitrogen and organic matter of the soil is the most important practical problem of American agriculture.

If conditions in certain irrigated soils of the arid west are such as to bring about such an abnormal fixation of atmospheric nitrogen as to render the soil non-productive, due to the production of enormous amounts of nitrates, it is important that the conditions governing such fixation may be clearly understood in order that advantage may be taken of this

[2] Headden, Colorado Exp. Sta. Bul. 155.
[3] Hilgard, "Soils," p. 448.
[4] Headden, Colorado Exp. Sta. Bul. 155.
[5] Sackett, Colorado Exp. Station Bul. 179.
[6] Stewart and Greaves, Utah Exp. Sta. Bul. 114, 1911.
[7] Stewart and Peterson, Utah Exp. Sta. Bul. 134, 1914; *Jr. Am. Soc. Agron.*, Vol. 6, 241.

process in other soils and thus solve the most important problem in American agriculture.

These niter spots are characterized by the following conditions: (1) The presence of large quantities of nitrates; (2) the inevitable presence (usually larger quantities) of other soluble salts such as the chlorides and sulphates of sodium, potassium, calcium and magnesium; (3) the absence of appreciable quantities of soluble carbonates; (4) the presence of a dark brown color or stain; (5) the formation of a hard crust on the surface of the soil; (6) underneath the crust there is a layer of dry dust with fine alkali salt crystals which gives an ash-like or mealy condition of the soil; (7) beneath the ash the soil is moist, sticky and glistening. These niter spots usually occur in cultivated soil after it has been irrigated for a few years. But they likewise occur in the non-irrigated and non-arable soils of the mountains wherever moisture conditions are favorable to the concentration of the salts.

Over four hundred samples of the country rock were collected from the original rock adjacent to the soils in the affected areas and these were analyzed for nitrates and other soluble salts. These data form a basis for the theory developed by us. The soils most affected are those derived from the Mancos shales of the cretaceous as well as from the shales and sandstones of the tertiary deposits.

Sufficient evidence has been presented by us to show conclusively that these nitrate accumulations are the direct result of the concentrating and leaching action of the irrigating water upon the nitrates already existing in the original country rock adjacent to and underneath the affected soils. Briefly summarized, our case rests upon the following evidence: (1) Highly productive, irrigated soils rich in organic matter, free from alkali, are also free from niter spots, or nitrate accumulations. (2) Alkali and nitrate-free soils, under similar climatic conditions, irrigated with water from the same river, geographically adjacent, but derived from different geological series, have been cultivated and irrigated for ten times as long as the niter soils, yet are free from nitrate accumulations. (3) The total alkali salts of any given spot fluctuate from year to year; the nitric nitrogen and total salts, as measured by the chlorine content, increase and decrease in quantity in the same general ratio. The same influences must be at work on both. (4) The amount of chlorides and sulphates present are enormous in quantity and are sufficient in themselves to render the soil non-productive. Thus in a characteristic spot a noted increase of nitric nitrogen in four years of 621 pounds was accompanied by an increase of 128 tons of chlorine and 315 tons of total alkali salts. (5) There is no record of "niter spots" free from these other salts; the nitrates and other alkali salts must therefore be associated in some manner. (6) Lipman[8] has shown conclusively that alkali salts not only do not have a stimulating effect on the production of nitrates in alkali soils, but, on the contrary, nitrification is inhibited. (7) The fixation of atmospheric nitrogen in the non-irrigated soils[9] of Utah is much greater than in the niter soils, yet the nitric nitrogen content of the latter is only normal, being less than six parts per million. (8) Niter spots, possessing all the characteristics, occur in the virgin state in the uncultivated and non-arable areas of the near-by hills wherever the water conditions are such as to cause a leaching and concentrating action on the soluble salts, including the nitrates preexisting in the rock itself. (9) There are large quantities of nitrates in a widely disseminated form, occurring in the country rock adjacent to and underneath the affected soils. (10) These nitrate accumulations although not of any commercial economic importance, so far as known, because of their wide distribution, are more than sufficient, being greater in quantity than those of Chili, to account in full for the nitrate accumulations observed in the alkali soils.

This evidence leads us to the inevitable conclusion that the non-symbiotic bacteria are not

[8] Lipman, *Central f. Bkt.*, Abt. II., Bd. 33, s. 305.

[9] Greaves, *Central f. Bkt.*, Abt. II., Bd. 41, p. 444.

responsible for the production of the nitrates noted in the niter spots of the affected soils of the arid west and their presence there is only incidental and of *no more economic importance than their more abundant occurrence in other normal "niter"-free soils of the arid regions.* The nitrates present in the "niter spots" are the direct result of the leaching and concentrating action of the ground water upon the nitrates preexisting in the country rock adjacent to or underneath the soil of the affected area.

The nature and source of the color present in these spots is of no economic importance whatever except as evidence in support of one or the other of the theories regarding the origin of the nitrates themselves. The azotobacter are in no way concerned in the production of this color. In the normal dry farm soils of Utah the maximum fixation of nitrogen by the non-symbiotic organisms is greater than in the niter soils, yet these soils are free from nitrate accumulation and the color and other characteristics likewise are absent.

The color is due to the solvent and decomposing action of the nitrates upon the old organic matter or humus in the soil. The source of the old organic matter, like the nitrates, may be found in the adjacent shales which as already pointed out are coal- and oil-bearing. Some of the most important coal deposits of Utah and Colorado are found in these shales and sandstones. As a result the ordinary shale contains more or less organic matter. As an illustration, the analysis of twelve samples of shales from near Grand Junction, Colorado, gave an organic nitrogen content of 1,840 pounds per two million pounds of shale.

The assumption of the hydrolyzing action of sodium nitrate and the subsequent humification of the organic matter of the soil to form the brownish colored organic compounds *is as unnecessary as it is untenable.* The solvent and decomposing action (double decomposition) of the nitrates of sodium and potassium upon the old organic matter or humus already occurring in the shale and sandstone is sufficient to account for the production of the color in these "niter spots."

The nitrates of sodium and potassium do have a solvent action on organic matter as already demonstrated.[10] A rich greenhouse soil already abundantly supplied with nitrate was extracted with water for 24 hours as in the official humus determination. A highly colored solution resulted. An aliquot portion on evaporation to dryness and ignition gave a loss of 0.57 per cent. The soil was then extracted with the various soluble salts of sodium, potassium, magnesium and calcium. The variation in intensity of the color was very pronounced with the extract of the different salts. How can this fact be best conveyed to the reader is an important question which arose? The following data were obtained on evaporation and subsequent ignition of an aliquot portion of the extract:

Bases	Sodium				Potassium				Magnesium			Calcium	
Salts	CO_3	SO_4	Cl	NO_3	CO_3	SO_4	Cl	NO_3	SO_4	Cl	NO_3	Cl	NO_3
Per cent. dissolved	5.7	1.19	0.72	0.8	4.2	0.78	0.57	1.4	0.57	0.48	0.49	0.19	0.20

Notwithstanding the confessedly crude method of conveying a conception of the variation in color extracted by the several salts, considering the results as a whole two important facts are evident: (1) the solvent action upon the organic matter of the salts of sodium and potassium and (2) the repressive action of the salts of magnesium and calcium. The solvent action is very pronounced in the cases of sodium and potassium carbonate and the repressive action is very pronounced in the case of the salts of calcium. How may we interpret these data?

The aqueous extract alone dissolved some colored organic matter due undoubtedly to the fact that the soil itself contained *several hundred parts per million of nitrate.* Likewise,

[10] Stewart and Peterson, *Jr. Am. Soc. Agron.*, Vol. 6, p. 247, 1914.

owing to the presence of this nitrate in the soil, the chlorides, sulphates of sodium and potassium exert a solvent action on the organic matter. The potassium nitrate has a decomposition, while the solvent action of the more pronounced solvent action on the organic matter, which is intensified by double carbonates of sodium and potassium are undoubtedly intensified by the hydrolyzation and consequent production of caustic alkali. The salts of calcium exert a repressive action because of the double decomposition and the union of the calcium to formed insoluble calcium salts of the colored organic acids present as already explained. In the presence of old organic material such as occurs in the coal-bearing shale the humifying action of *either the carbonates or other salts* is entirely negligible but it undoubtedly is true that the humifying action upon fresh organic matter of the caustic soda produced by the hydrolyzation of the sodium carbonate is an important factor in the production of the black color of the black alkali spots of alkali soils.

Furthermore, the solvent action of potassium nitrate on old organic matter may be observed in the extraction of peaty soils in the determination of acidity of the soil by the Hopkins method. The potassium nitrate extract of peaty soils in this determination is always colored, due to dissolved organic material. The intensity of the color frequently is so great as to give considerable trouble in the subsequent titration of the extract with an alkali, because the change in color of the indicator can not be observed. The solubility of the old organic matter of peaty soils in potassium nitrate is certainly entirely analogous to the solubility of the old organic matter in the coal-bearing shales and sandstones which constitute the parent material out of which the soils of the "niter" areas are formed.

The color thus can be readily accounted for without the instrumentality of the bacteria, while, moreover, artificial niter spots may be produced in the laboratory on a small scale under conditions which preclude the presence of any bacterial life whatever. Three hundred grams of a greenhouse soil, rich in humus, was placed in small evaporating dishes and the dish filled with a 10-per-cent. solution of sodium nitrate. The solution was then allowed to slowly evaporate by the sun's rays. When all the moisture had evaporated there was produced characteristic niter spots including the color, hard crust and the mealy crystalline condition underneath the crust due to the accumulation of the soluble salts. *These spots were likewise produced when the nitrate was added in the solid form and the moisture added with a saturated solution of mercuric chloride or a 5 per cent. solution of carbolic acid. Control samples of the same soil, in the absence of the nitrate, with or without the antiseptic, failed to produce either the color or other indications of the niter spots.* It is evident, therefore, that the bacteria play no important rôle in either the production of the nitrates or color of the "niter spots" of certain western soils.

In addition to the evidence already published, a detailed paper dealing with the problem as it affects other soils than those already discussed is being prepared and will be published later elsewhere.

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MOTTLED LIMESTONES AND THEIR BEARING ON THE ORIGIN OF DOLOMITE[1]

Several examples of limestone mottled with dolomite have been described during the past few years, but R. C. Wallace was the first to attempt seriously to interpret their meaning. In a very suggestive paper entitled "Pseudobrecciation in Ordovician Limestones in Manitoba"[2] he points out that the dolomite patches in these limestones follow fucoid-like markings suggesting algæ, and concludes that the relationship has resulted from a process of local replacement produced by the magnesia contained in algæ which were imbedded in the

[1] With the permission of the director of the Iowa Geological Survey.

[2] *Jour. Geol.*, Vol. XXI., 1913, pp. 402–421.

limestone at the time it was deposited. He therefore regards the magnesia as indigenous.

It has appeared to the writer that the agents which produced the mottling might be closely bound up with dolomite formation on an extensive scale, and he has accordingly given the phenomenon careful attention in connection with his studies on the origin of dolomite. In the occurrences of mottled limestones observed by him the dolomite patches follow fucoid markings similar to those described by Wallace in some instances, but in others they are very irregular and show no guiding influence. For the origin of both types it seems necessary to adopt an alternative hypothesis; namely, that the magnesia was subsequently introduced into the limestone from without, and that the mottling has resulted from the selective replacement of fucoid markings in the one case, and from the spreading out of the alteration from certain favorable centers in the other. Consistent with this view are the following facts:

1. The existence of unaltered fucoid markings containing less than two per cent. of magnesium carbonate in association with dolomitic ones.

2. The association of both types of mottling with dolomite seams and other evidences of imperfect dolomitization.

3. The graduation of mottled beds into beds which are uniformly dolomitic, both laterally and vertically.

4. The existence of every gradation between limestone showing incipient mottling and true dolomite.

Thus it appears to the writer that all examples of mottling examined by him represent an incipient stage in the process of dolomitization, and it is believed that many dolomites have passed through such a stage in the progress of their formation. Here, then, we have a clue to the origin of all those masses of dolomite with which such mottling is associated.

With regard to the time of the alteration which produced the mottling, there is convincing evidence that it took place in the majority of cases prior to or contemporaneously with the recrystallization of the limestone. Several features lend support to this conclusion; namely, the development of perfect rhombs of dolomite showing no growth interference effects in the limestone about the borders of the dolomite patches; the occasional presence of zonal growths of dolomite and calcite; the tendency of the dolomite areas to spread out uniformly in all directions as the dolomitization proceeded rather than to develop veinlets; and the association of the mottling with imperfect dolomitization effects along original lines of weakness such as bedding planes rather than along secondary structures such as joints or fractures. It seems probable, therefore, that the mottling was produced while the limestones were still beneath the sea, and that the sea water contributed the magnesia.

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SERPENT INSTINCT IN MAN

TO THE EDITOR OF SCIENCE: In the very entertaining and instructive work by Col. Wm. C. Gorgas, "Sanitation in Panama," the author in the concluding pages of the book gives expression to certain philosophizing ideas relating to the earliest period of the existence of the human race, and makes the point that before the discovery by primitive man of fire and clothing his habitat must have been confined to that part of the earth that lies "between the tropics of Cancer and Capricorn," or within narrow limits outside of that region.

There has been much speculation concerning the focus from which the world's population became diffused over the earth's surface, and, at least as far as regards the white peoples of Europe and Asia, the consensus of scientific opinion has fixed upon some locality in central Asia as the probable focus of origin, though the exact or approximate locality seems not to have been defined.

In the writer's reflections along this line there has presented itself to his contemplation one very pronounced and mysterious mental attribute still pertinaciously clinging to the white race at least, which seems to carry evi-

dence corroborative of the above conclusion, pointing, however, more specifically to India as the location of man's early development.

Reference is made to the general prevalence of a deep-seated abhorrence of the serpent and all serpent forms among the white race. This abhorrence of serpents is really a deep-seated animal instinct, which has survived long after the conditions that gave it origin.

Rational persons who are informed on the subject know that the great majority of the snakes to be encountered in this country are entirely harmless, being without venom or fangs; and indeed the writer has determined, to his own satisfaction at least, that in this particular region the only one of the snake family that is a menace to human life is the now rarely encountered *Crotalus horridus,* using the term in a generic sense.

And yet, any intelligent person when unexpectedly brought into close proximity to any kind of a snake, large or small, venomous or non-venomous, or even a semblance of a snake, is suddenly seized by a panic of horror and fear, with an impulse to spring away out of the serpent's reach as quickly as possible in a sort of blind terror.

The probable origin of this instinctive horror of serpents that still dominates the mind of civilized man was during the countless generations when early man was slowly climbing up from his animal ancestry to his present eminence as *Homo sapiens.* Being without fire and without clothing or shelter, he was peculiarly defenseless in an environment beset by deadly serpents, against this, probably the greatest danger and greatest menace to racial survival that he had to encounter. Hence his instinctive horror of the serpent form.

The idea that India was the "cradle" of the white race at least, with its serpent environment threatening racial existence for a very long period of its primitive development, appears to receive some degree of confirmation from the fact that among the inhabitants of India at the present time the annual mortality from attacks of serpents exceeds twenty thousand, notwithstanding the efforts of the British authorities to suppress the evil.

The serpent instinct in man has a close analogy in a similar instinct that characterizes the domestic horse of the present time, to which allusion has been made by writers on the subject. It is a familiar fact to every one who has to do with horses, the proneness of the horse to exhibit an insane and uncontrollable fear of any unfamiliar wayside object. Indeed the phenomenon is such a commonplace that probably very few persons have given a thought in explanation of what appears to be a wholly unaccountable mystery.

The suggestion that has been offered with compelling force to account for this curious horse instinct is on parallel lines with that offered above to account for man's serpent instinct, both of which in the nature of animal instincts are intense and deep seated, and have long survived the conditions that gave rise to them.

In the case of the horse, for a very long period of his racial development he was subjected to one danger exceeding all others in magnitude by which racial survival was constantly threatened. This danger was embodied in the predacious beasts that infested the horse's early environment, mainly of the feline family, that lay in wait concealed by bushes or other cover for the opportunity to spring upon him and devour him. The horse had no means of defense against this danger except alertness in eluding the spring of his enemy and fleetness of foot to escape pursuit. The individual horses that developed these qualities most highly survived, while those that failed to reach an efficient standard fell victims to their enemies.

And we now see, thousands of years after the domestication of the horse, that he suddenly falls into a senseless panic and flees at breakneck speed from an imaginary danger behind him, heedless of real dangers ahead which not infrequently cause him a broken neck.

The instinctive fear of imaginary dangers in the horse, and the same kind of fear of serpents in man, appear to have had a similar genesis in the early experiences of both races.

T. G. Dabney

THE TEACHING OF ELEMENTARY DYNAMICS

To THE EDITOR OF SCIENCE: Will you please note that the following typographical errors should be corrected in my article in SCIENCE of December 24, page 901:

First column, after (4) "Impulse = Momentum" should be raised two lines, and "From (3)" should be brought down to the line containing $T = 2S/V$.

After (5) "Work done = Kinetic energy" should likewise be raised and "In (4) let" lowered.

Sixth line from bottom, for $A = M/F$ read $A = F/M$.

Second column, third line, for $Wg/32.1740$ read $Wg_1/32.1740$.

WM. KENT

MONTCLAIR, N. J.

SCIENTIFIC BOOKS

Medical and Veterinary Entomology: A Textbook for use in Schools and Colleges, as well as a Handbook for the use of Physicians, Veterinarians and Public Health Officials. By WILLIAM B. HERMS, Associate Professor of Parasitology in the University of California. The Macmillan Company, 1915. Price $4.00.

This is a time in the history of the world when "long-felt wants" are rapidly being filled. A year ago an up-to-date handbook of medical entomology did not exist in printed form, and now we have two excellent works on this subject. The first to appear, "A Handbook of Medical Entomology," by Dr. W. A. Riley and Dr. O. A. Johannsen, of Cornell University, was reviewed in SCIENCE, October 15, 1915. The second, which has just appeared, is a large, well-illustrated and competent book of about four hundred pages, and has been written by a man who has been investigating and teaching the general subject for six years or more at Berkeley. Much of the matter contained in the book was prepared for the press some six years ago, but owing to the very many advances which are constantly being made in the field covered by the book it was withheld until this time, much revised and added to, and now appears at a moment when it is very welcome. Although the author states that his book is not intended to be a comprehensive treatise, but is rather an attempt to systematize the subject and to assist in securing for it a place among the applied biological sciences, it has greatly the appearance of comprehensiveness. The whole field is included in the treatment, and of course for the purposes of the volume the ticks and mites are among the subjects treated. There is also a chapter on venomous insects and Arachnids.

A thoroughly good compilation arranged in a natural and systematic manner would have been a most useful book for the teacher and student as well as the practitioner, but in addition to being such a compilation this book includes a large amount of new material based upon the researches of Professor Herms and his assistants. For example, he details specific experiments in the transmission of bacteria by cockroaches and gives counts of the bacteria of the different parts of the body of the croton bug. His chapters on organization and cost of mosquito control work and on organization and control work against the house fly are especially strong from the very fact that they are based upon extended experience and upon very many experiments. Professor Herms himself has been the adviser in nearly all of the organization and control work of this kind which has been carried out on the Pacific coast, and what he says in this direction is in the highest degree authoritative. His chapter on the stable fly (*Stomoxys calcitrans*) is also strong, and his conclusion to the effect that it is doubtful that this species is the usual agent in spreading polyomyelitis in nature is based upon a careful series of experimental laboratory work with this species and monkeys. The treatment of the important group of fleas and ticks is noticeably full, and his consideration of bee stings, and especially of the morphology and operation of the sting, is very welcome.

In his generalizations concerning mosquito life history, on page 91 and the following, he does not sufficiently point out, it seems to the writer, the enormous differences that exist in the life histories of different species, which

are in fact so great that it is difficult to generalize except in the broadest way. There are very few slips in the book, but it is misleading to read on page 113 that Surgeon-General Sternberg established in 1899 a commission "to study the yellow-fever mosquito theory in Cuba." As a matter of fact the commission was established "for the purpose of pursuing scientific investigations with reference to the infectious diseases prevalent on the Island of Cuba," and it was, as is shown in Agramonte's important article in the last number of *The Scientific Monthly*, the commission's idea experimentally to test Finlay's theory. In this error Professor Herms probably followed the writer's early book "Mosquitoes" (New York, 1901), but it has been several times corrected.

There is much to be said in favor of the rapidly growing substitution of half-tones from good clear photographs for photo-engravings of line and stipple drawings, but it is possible to carry this to an extreme. For example, the illustration of the two-spotted corsair (*Rasahus biguttatus*), page 78, can by no means be considered as a competent illustration of this species, unless it were stated to be a specimen crushed by a violent slap when engaged in sucking the blood of the author! This, however, is an exception, and the great majority of the figures are very good.

Very many students in the universities and colleges and in the medical colleges as well are turning their attention to medical entomology, and perhaps the most rapid advances in the whole field of economic entomology in the immediate future will be in this direction. The timeliness and usefulness of Professor Herm's book under these circumstances can not be doubted, and both he and his department at Berkeley are to be congratulated.

L. O. Howard

Senescence and Rejuvenescence. By C. M. Child. Chicago, The University of Chicago Press. Pp. xi + 481. 201 figures.

A number of biologists have attempted to solve the problem of rejuvenescence by denying its existence. Living substance, they say, grows old, but can never grow young. In each individual some part remains young and it is this that supplies the substance for the process of senescence. Professor Child is not of this belief. To him "growing young" is as real a phase of development as "growing old." This is natural to one who has seen and described the formation of sex-cells from tissue cells and to whom structure is merely a product of function. For some time he has been making a study of rate of metabolism as a criterion of senescence and rejuvenescence and the present volume is largely an exposition of the results of these experiments with a discussion of their significance for the problem of development.

A considerable mass of evidence, according to the author, proves that susceptibility to the cyanides, ethyl alcohol, ethyl ether and similar substances is directly proportional to the rate of metabolism when the strength of the solution is sufficient to kill within a few hours. On the other hand, if the solution is so weak that there is an acclimation effect the animals with the higher rate live longer than those with the lower rate. Starving animals form an exception to the latter rule.

These methods show that increase in age is in general accompanied by decrease in rate of metabolism, but that there are one or more periods in each life cycle that are accompanied by an increase in rate. According to Child these are the periods of rejuvenescence and are found not only in the early cleavage stages following the union of the egg and spermatozoon, but also in the early period of regeneration, in starving animals and under other conditions. He concludes from these considerations that rejuvenescence is a fundamental phenomenon in development and is by no means confined to sexual reproduction. As a matter of fact the changes in metabolism due to amount and character of food and to other environmental factors are according to him in no essential respect different from the others. This attempt to prove fundamental similarity between minor metabolic changes and the major proccesses of the life cycle may be criticized, but Child considers it to be one of the principal virtues of his discussion. When put in physio-

logical terms senescence does not follow an unbroken course.

Non-energistic formulæ do not appeal to the author. In fact he seems to delight in showing his antagonism toward them. For instance, he says that "attempts to connect particular facts with particular chromosomes or parts of chromosomes are not at the present, properly speaking, scientific hypotheses." This and similar statements leave no doubt as to the direction of Professor Child's interest. They may, unfortunately, keep some readers from a fair consideration of the very valuable results of his work.

The extent of the ground covered in the book is well indicated by the titles of the five parts. I. The Problem of Organic Constitution. II. An Experimental Study of Physiological Senescence and Rejuvenescence in the Lower Animals. III. Individualism and Reproduction in Relation to the Age Cycle. IV. Gametic Reproduction in Relation to the Age Cycle. V. Theoretical and Critical. About half of the space is devoted to the experiments of the author and the greater part of the observations appear here for the first time.

The importance of the facts and their general interest make it a matter for congratulation that they have appeared in this connected form rather than in separate papers. The book will be welcomed by all those interested in the problem of development.

CHARLES ZELENY

Land Magnetic Observations, 1911–1913 and Reports on Special Researches. By L. A. BAUER AND J. A. FLEMING. Washington, D. C., 1915. Publication No. 175, Vol. 2, of the Carnegie Institution of Washington. 4to. Pp. v + 278. 13 plates, 9 text-figures.

This is the second volume of the "Researches of the Department of Terrestrial Magnetism," the first volume having dealt with the magnetic observations on land from 1905 to 1910. Some idea of the magnitude of the work carried out under Dr. Bauer's energetic leadership can be gained from the statement that during the eight years following the founding of the department the various expeditions by land and sea covered in all nearly a million miles. Observations were made in 103 different countries and island groups. The results of these expeditions and of special investigations have been embodied in about 125 articles and publications. It is now expected that one of the chief objects for which the Department of Terrestrial Magnetism was founded, the general magnetic survey of the globe between latitudes 70° N. and 65° S., will be completed in 1916. Up to the present time this remarkable achievement has been accomplished without loss of life.

In view of the ever-changing values of the magnetic elements and of our imperfect knowledge of the secular variation in many parts of the earth, it is of immense importance in the analysis of the earth's magnetic field, and thereby ultimately to the navigator and surveyor, that magnetic data be secured for the whole globe at as nearly the same epoch as possible. As has often been remarked, we can never hope to know much about the magnetic field in a vertical direction above or below the earth's surface. Hence a minute and accurate knowledge of the magnetic field over the surface to which we are confined is of all the more importance. It will be greatly to the credit of the Carnegie Institution to have accomplished the task in less than a decade. No cooperation of civilized governments could be expected to do this. It is precisely in work of this sort that a richly endowed private institution can render its greatest service.

The first part of the volume is devoted to a description of instruments, with their corrections, and the magnetic standards finally adopted. Two new universal types of magnetometer have been developed by the department, and seven complete instruments have been constructed in the department's shop. Many persons not directly interested in magnetism would find it to their advantage to examine the ingenuity and elegance of some of the instrumental details.

The old-fashioned dip circle, with its eccentricities both literal and figurative, has largely given place to the earth inductor. Nothing is said about trouble from thermo-electric cur-

rents in the use of the latter instrument, though due precautions must have been taken to avoid any possible error from this source. It is unfortunate that the Kelvin type of galvanometer still has to be retained, in most cases at least, on account of the stray field produced by the permanent magnet of the moving coil galvanometers. Dip values obtained with the earth inductor are now consistent to within about one minute of arc. The corrections for individual dip needles usually amount to very much more than this.

The tabulated results of observations are comprised in about forty pages. The data include geographical position, date, hour, and values of declination, dip, and horizontal intensity, for a very large number of stations in all of the continents, the antarctic regions, and chief island groups. No reduction of values to a common epoch is attempted. Intensities are given in C.G.S. units. Physicists may well question the necessity of introducing, at the headings of columns of horizontal intensity, the special symbol Γ, which, we are told, represents one C.G.S. unit. In the already highly be-symboled state of science would we not better rest content with that "perfectly good" name for the C.G.S. unit, which is also a reminder of the father of the science of terrestrial magnetism, the *gauss*?

In connection with the land observations, instrumental and other assistance has been furnished in cooperation with various organizations and expeditions. The Australasian Antarctic Expedition and the Crocker Land Expedition may be especially named. The observers' field reports are replete with notes of interest to the geologist, botanist, biologist and explorer. If one seeks information concerning selection of firearms, feeding of camels, defense against Bedawins, or canoeing in the Canadian wilderness, he will find it here.

A valuable feature of the book is the detailed description of the research buildings recently erected near Rock Creek Park. The main building is of fireproof construction, and so stable that no perceptible vibration is transmitted to the most sensitive galvanometers, even when the machinery in the basement is running. For work demanding freedom from magnetic disturbances, a separate non-magnetic building has been erected. Those interested in the building and equipment of laboratories of any kind will profit by a study of these carefully planned structures.

The only special researches recorded in this volume are some miscellaneous observations made in Samoa at the time of the solar eclipse of April 28, 1911, and a very detailed description of the comparisons of magnetic standards made at various observatories. The present attainable precision in magnetic observations may be learned from the statement that "the corrections, on absolute standards, for the declination and inclination may be in error by 0′.1 or 0′.2 and for the horizontal intensity by about 0.0001*H*."

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SPECIAL ARTICLES

SOME SUGGESTIONS ON METHODS FOR THE STUDY OF NITRIFICATION[1]

During recent years the use of one gram of dried blood, tankage, cotton-seed meal, bone meal, etc., mixed with 100 gm. of soil, has commonly been employed in laboratory studies on nitrification. In some cases as much as 2 per cent. of these materials has been used. On the other hand, a much smaller amount of ammonium sulfate is usually added because of its greater solubility and recognized toxicity to the nitrifying organisms when present in excessive concentrations. The results are frequently stated in terms of the absolute amounts of nitric nitrogen formed rather than in percentages of nitrogen nitrified. Comparisons and conclusions on the relative nitrifiability of nitrogenous fertilizers are commonly made on the basis of evidence obtained in this way.

In the course of studies on nitrification at the University of California Citrus Experiment Station, the writer recently observed a wide range of variation in the nitrification of

[1] Paper No. 20, Citrus Experiment Station, College of Agriculture, University of California, Riverside, Calif.

dried blood in soil from fertilizer plats of an experiment that has been in progress for eight years. In some cases the use of one per cent. dried blood resulted in no nitrification at all in four weeks' incubation, but rather a partial loss of the nitrates originally present. In soil from other plats, however, vigorous nitrification took place. The soil throughout these plats has been derived from disintegrated granite and is quite sandy and very low in organic matter and nitrogen. In view of the extensive use now being made of dried blood, and the scientific interest attached to the subject, an extended study of nitrification in Southern California soils has been undertaken. Such questions as the relative rates of nitrification of dried blood, bone meal, ammonium sulfate, etc., the effects of lime, the influence of organic matter and other factors are being studied. The investigations are still in progress. Certain of the results already obtained, however, seem of sufficient interest to warrant preliminary discussion at the present time. Later, a more complete presentation of the investigation will be submitted.

At the outset it was found that vigorous ammonification of different organic fertilizers took place in all plats studied and that the addition of lime did not greatly affect either ammonification or nitrification. When the conventional amount of nitrogenous materials was added, however, dried blood was not nitrified in soil from certain plats, while bone meal and ammonium sulfate underwent vigorous nitrification. In soil from other plats no such difference was observed. The following results illustrate the difference in nitrification in two plats. 100 gm. of soil in duplicate was employed in each case.

Materials Added	Increase in Nitric. N. p. p. m. Plot B, Unfertilized	Plot U, Manure, Rock Phos. and Legume
1 gm. dried blood	— 2.8	170
1 gm. bone meal	92.8	154
0.15 gm. ammonium sulfate.	67.8	136

Similar observations have been reported from other soils of California.[2]

[2] Lipman and Burgess, Calif. Sta. Bull. 251 and 260, 1915.

It is of interest in this connection that certain plats in the field experiments, from which the above soils were drawn, have been fertilized annually for eight years with dried blood only, and that marked stimulation has resulted in the growth and vigor of the citrus trees, on the one hand, and in the yield of fruit, on the other. For example, the yield during the past two years has been increased more than 100 per cent. by the use of dried blood. Furthermore, a material increase in the nitrate content of the soil is found at the present time wherever dried blood has been applied, indicating that this material undergoes nitrification in the field.

Two questions, therefore, present themselves. First, why should dried blood fail to undergo nitrification in soil from certain plats but be nitrified vigorously in others, while at the same time bone meal and ammonium sulfate are capable of being vigorously nitrified in each? This question seems especially pertinent since ammonification, generally considered to be essential as preliminary to the nitrification of organic substances, takes place actively. Second, why does dried blood undergo nitrification in the field but not in the laboratory?

Entirely satisfactory answers to these questions can not now be given. Some light has been thrown on them, however, as will appear from the discussion below.

While the proportion of dried blood to soil employed in the above experiments was the same as is commonly used in laboratory experiments on nitrification, nevertheless, the possibility that excessive concentrations of dried blood had been employed was at once suggested. In the field experiments an annual application of 1,080 lbs. of dried blood per acre is now being made to certain plats, applied in approximately equal applications in February, April and July. The addition of 1 gm. per 100 gm. of soil, on the other hand, corresponds to an application of 15,000 lbs. per acre, estimating an acre foot at 3,000,000 lbs. and reckoning that the field application becomes incorporated with the soil to a depth of six inches. Accordingly, a series of laboratory

experiments was undertaken, using soil from a number of plats that had been fertilized differently. The samples were drawn on August 14. Varying amounts of dried blood, bone meal and ammonium sulfate were added and the series arranged so as to make possible a fair comparison of the rates of nitrification when approximately equal amounts of nitrogen had been acted upon simultaneously.[3] The following table sets forth a part of the results obtained:

Nitrification[4] *with the Use of Varying Amounts of Materials*

Nitrogenous Materials Added	Virgin Soil		Plot *M*, Unfertilized		Plot *O*, Fertilized with Manure and Rock Phos.	
	Nitric N Formed P.p.m.	Per Cent. N Nitrified	Nitric N Formed P.p.m.	Per Cent. N Nitrified	Nitric N Formed P.p.m.	Per Cent. N Nitrified
1 gm. dried blood...	−12	0	−16	0	277	20.9
0.25 gm. dried blood	24	7	100	33.3	101	30.6
0.0625 gm. dried blood.....	39	47.3	55	66.6	43	52.1
4 gm. bone meal.....	−10	0	− 1	0	149	8.8
1 gm. bone meal.....	75	17.6	76	17.9	181	42.6
0.25 gm. bone meal.	46	43.3	49	46.1	52	48.9
0.6 gm. am. sul.	−19	0	11	0.8	55	4.3
0.15 gm. am. sul. ...	31	9.8	62	19.5	119	37.5
0.0375 gm. am. sul..	35	44.1	54	68.2	73	92.0

Briefly, it was found that 1 per cent. dried blood failed to undergo nitrification in those soils which had not been consistently fertilized with organic manures and that in some cases 0.5 per cent. was not nitrified. On the other hand, when the concentration was reduced to 0.25 per cent. or less, vigorous nitrification took place in every case. It was found, however, that in most cases increasing percentages of the nitrogen added were nitrified as the amounts of dried blood were decreased down to 0.0625 per cent. Hence it would seem that even 0.25 per cent. dried blood, which is only one fourth the concentration commonly used in laboratory experiments, may inhibit nitrification to some extent in some soils. Similar statements may be made regarding the results obtained from the use of bone meal. The addition of large amounts of this material corresponding approximately to the larger amounts of nitrogen added as dried blood, failed to be nitrified in the same soils that showed inability to nitrify 1 per cent. dried blood. The smaller amounts, however, were actively converted into nitrate, but in no case more actively than similar amounts of nitrogen as dried blood.

In the case of ammonium sulfate, the results show that increasing percentages of the nitrogen were nitrified as the concentration decreased and that this material was most completely nitrified when added in the lowest concentration. Comparing the percentage of nitrification when the materials were added in low concentrations, similar to that employed in field practises, it is interesting to note that with only one exception out of the ten series of studies now made on the subject, ammonium sulfate was nitrified no more vigorously than dried blood, and in every case dried blood was nitrified more actively than such a low-grade nitrogenous material as bone meal. This feature of the results, therefore, is in harmony with common knowledge and experimental data obtained in humid regions. It should be added that other series of studies conducted at a different time, fully verify the above statements. The conclusions seem warranted, therefore, that dried blood will undergo nitrification in these soils fully as actively as the other materials studied, provided *an excessive concentration is not employed.*

The above data also indicate that before field comparisons on the nitrifiability of different materials can safely be drawn, it is neces-

[3] When the experiments were begun the dried blood was thought to contain 13 per cent. nitrogen and the bone meal approximately 3 per cent. Analyses later showed them to contain 13.2 per cent. and 4.25 per cent., respectively. Consequently the amounts of nitrogen added as bone meal were higher than had been intended, but this does not materially modify the conclusions to be drawn, since a wide range of concentrations was provided. The ammonium sulfate was Baker's C.P.

[4] The data represent the increase in nitric N over that found in separate portions of soil incubated for the same time under similar conditions, but without the addition of nitrogenous material. The minus sign (—) indicates loss of nitrate.

sary to study the rates of decomposition in equal and varying concentrations of actual nitrogen. It seems also that if practical conclusions are to be drawn, it is necessary to approximate field conditions, as nearly as possible, in laboratory tests. This point, it seems to the writer, has not been sufficiently recognized in many soil bacteriological studies. The conditions ensuing when relatively large amounts of nitrogenous substances such as dried blood, tankage, etc., undergo decomposition, may conceivably become extremely abnormal and greatly dissimilar to those ensuing under field practise. The products arising from the decomposition of 1 per cent. dried blood, under some conditions of bacterial activity may exert, either directly or indirectly, important influences on the further action of the micro-organisms present. Such, for example, is known to be the case in the bacterial decomposition of milk. In fact the course and extent of many chemical and biochemical reactions is known to be greatly modified by the products of the action.

As stated above, dried blood undergoes vigorous ammonification in the several plats studied. It has been suggested that the conditions produced by the high concentrations of ammonia or ammonium carbonate, formed from the larger amounts of dried blood and bone meal, may have been unfavorable to the activity of the nitrifiers. With the hope of securing light on this point, preliminary studies have been made by adding varying amounts of ammonium hydrate and ammonium carbonate in addition to 0.25 per cent. dried blood, using a soil in which no nitrification of 1 per cent. dried blood takes place. The results showed that in every case the addition of either ammonium hydrate or ammonium carbonate partially inhibited nitrification even in the low concentration of 5 mg. per 100 gm. soil. Whether the ammonia was actually toxic to the nitrifying organisms, or reacted unfavorably through physical effects produced or otherwise, can not be definitely stated at the present time.

Evidence has been obtained that there is considerable seasonal variation in regard to the inhibiting effect of 1 per cent. dried blood. With samples drawn from one plat in April and June, respectively, 1 per cent. dried blood underwent active nitrification, while no nitrification took place in samples taken August 14. In each case 0.5 per cent. and less were actively nitrified. Whatever may be the cause of this phenomenon, the fact still remains to be explained that 1 per cent. dried blood brought about toxic conditions in certain plats, but not pronouncedly so in others.

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SOME EXPERIMENTS WITH AGENTS CALCULATED TO KILL THE TROMBIDIUM HOLOSERICEUM

THE *Trombidium holosericeum* or common chicken mite is present in most hen houses throughout the country. It is very troublesome in the hotter months, especially July and August, when it finds climatic conditions favorable for its more rapid multiplication. The mites hide in clusters, in the cracks and crevices of the roost pole and in the crack where the roost pole rests on its support. Here they lay their eggs and the young and old emerge to attack the chickens at night.

The mite finds its way to the hen at night and with its conical piercing apparatus attacks the skin and draws blood. After its feast it leaves the hen and returns to its hiding place.

In searching the literature at hand in the library of the office of poultry investigations and pathology of this station no trace could be found where scientific tests and records had been made to determine just what effect the various parasiticides have upon mites.

There is common belief that tobacco clippings, sulphur, paris green, and a host of liquids are great destroyers of these formidable foes of the poultry house, but no one so far as we could find has actually made the tests. It was thought best to try a score of the more common agents used and to run duplicate tests.

Mode of Tests.—The tests were run either in open tumblers or sauce dishes so as to have an abundance of air present and to have the

tests as nearly under normal conditions as possible.

Agents Used.—The agents used fall into three classes, namely: Powders not giving off gas, powders that give off gases, and liquids. Tests were run with sulphur, air-slaked lime, paris green, naphthalene, gasoline, carbolic acid, insect powder, tobacco stems and dust, crude carbolic acid, 5 per cent. carbolic acid, 1 per cent. kreso dip, 2 per cent. kreso dip, 5 per cent. naphthalene in kerosene and 10 per cent. formaldehyde.

Sulphur.—Air-slaked lime was placed in the bottom of a tumbler. At the end of 24 hours, the mites had accumulated in a cluster in the center of the dry lime. Upon being poured out upon a paper they were still found to remain vigorous. Dry air-slaked lime has apparently no injurious effect upon them.

Paris Green.—Dry paris green (powder) was placed in the bottom of a tumbler and several hundred mites placed in the powder and stirred up. At the end of 48 hours the mites had formed in a cluster in one edge of the powder. Upon being removed they were found to be as vigorous as before being placed in the paris green. Dry paris green has apparently no ill effect upon mites.

Naphthalene (Powdered Moth Balls).—A quantity of pulverized moth balls was placed in the bottom of a tumbler and several hundred vigorous mites placed on the surface. At the end of 30 minutes motion was not so active and at the end of 45 minutes all motion ceased. Upon being removed and placed upon paper all mites were found to be dead.

Tobacco Bits.—Bits of tobacco leaves, the sweepings from the floor of a tobacco factory, were placed in the bottom of a tumbler and several hundred very active mites placed among the tobacco. Frequent observations were made and at the end of 72 hours the mites were as active as when they were placed in the tumbler.

Insect Powder.—A powder prepared in this laboratory consists of gasoline three parts, crude carbolic acid 1 part, and plaster of paris sufficient to make a rather dry mixture. This was passed through a sieve on to paper and after one hour was placed in tight jars till needed. A quantity of this powder was placed in the bottom of a tumbler and several hundred active mites placed in the material and mixed with it. At the end of one minute all mites were dead.

Five Per Cent. Carbolic Acid Solution in Water.—A quantity of a five-per-cent. aqueous solution of carbolic acid was poured out into a saucer and several hundred mites placed on one side, and the dish then tilted till all the mites were wet, then the liquid drained from them, the mites remaining on the wet surface for observation. In 30 seconds all mites were dead.

One Per Cent. Naphthalene in Kerosene.—One per cent. powdered moth balls dissolved in kerosene was tested. A quantity of this fluid was poured into a saucer and several hundred mites placed on the opposite side of the saucer then immersed as in the preceding test. In 30 seconds all mites in test were dead.

Crude Carbolic Acid.—Crude carbolic acid was poured into a saucer and several hundred mites placed on one side were immersed as in the preceding test. In 20 seconds all mites in the test were dead.

One Per Cent. Kreso Dip.—This liquid was poured into a saucer and several hundred mites subjected as in the preceding tests. At the end of four minutes motions slowed and at the end of ten minutes all mites in the test were dead.

Two Per Cent. Kreso Dip.—Test conducted as the preceding. At the end of two minutes motion was retarded and all mites in the test were dead at the end of four minutes.

Ten Per Cent. Formaldehyde.—The test was conducted as in the preceding. At the end of ten minutes all the mites in the test were dead.

Summary

Duplicate tests were run to determine the action, if any, of powdered sulphur, air-slaked lime, paris green and naphthalene upon the *Trombidium holosericeum* (the chicken mite).

It was found that though sulphur in solution as in lime and sulphur dip is an efficient parasiticide, that although paris green in solu-

tion is a violent poison because of its arsenic content and although tobacco leaves contain nicotine which when in solution is an effective parasiticide, yet these agents in their dry state do not destroy mites.

Duplicate tests were run with naphthalene or powdered moth balls which on account of its volatile substances emitted, killed all mites in the tests in 45 minutes.

Insect powder containing gasoline and crude carbolic acid, on account of the volatile substances given off, killed all mites in one minute.

In duplicate tests, solutions sufficiently concentrated killed in the following lengths of time: Crude carbolic acid, 20 seconds. Five per cent. carbolic acid, one minute. One per cent. naphthalene in kerosene, 30 seconds. One per cent. kreso dip ten minutes and two per cent. four minutes. Ten per cent. formaldehyde ten minutes.

Conclusions

In order that parasiticides be effective in the destruction of the mites they must either be in solution or be capable of giving off volatile substances which in themselves are destructive.

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THE GROWTH OF BONE IN CRETACEOUS TIMES

PALEONTOLOGISTS have, for many years, been acquainted with the curious conical portions of young plesiosaurian propodials and, also, they have observed definite openings on the edges of many of the flattened limb bones. One of these openings has, in some cases, been observed to lead into a canal, which, in turn, passes into a cavity, remarkably like the medullary canal of mammalian long bones. There has never been an adequate explanation for these curious conditions.

It has been generally assumed that the unusual characters mentioned above have been confined to the propodium (humerus or femur) but, recently, in studying the osteology of an immature plesiosaur from the Cretaceous, the writer noted all of these characters in a phalangeal bone. Further study of this problem will doubtless result in the discovery of these characteristics in all the long bones of the skeleton, especially in young and immature animals.

Andrews, Williston, Lydekker, Kiprijanoff and the writer have remarked on the unusual characters of this ancient group of aquatic reptiles and an attempted explanation[1] has been given of the curious conical ends of young propodials which formerly were regarded as epiphyses.

In regard to the openings, canal and cavity, the writer believes an adequate explanation of this condition is to be found in the developmental history of the mammalian long bones. Szymonowicz[2] has figured in a developing long bone of a mammal an opening which he terms "periosteal bud," similar in all respects to the opening in the edge of plesiosaurian limb bones. In both cases a canal leads from the foramen into the medullary cavity.

Jackson[3] has given a careful description and figure of a similar condition in the tibia of a three-day cat. Through this opening the blood vessels supplying the medullary cavity, the osteoblasts and marrow-forming elements migrate from the periphery into the medullary cavity.

Bidder[4] has further studied the conditions of bone formation and his contribution has suggested an explanation for certain curious features in the propodials of the plesiosaurs. The question arises as to whether it is legitimate to interpret developmental factors in the ancient reptiles from what occurs in modern mammals. That question is not yet settled, but assuming that an analogy may be safely drawn between developmental features in the

[1] Moodie, Roy L., "Reptilian Epiphyses," *Amer. Jour. Anat.*, Vol. 7, No. 4, pp. 443–467, Figs. 1–24, 1908.

[2] Szymonowicz, L., "A Text-book of Histology and Microscopic Anatomy of the Human Body," trans. by MacCallum, 1902, p. 270, Plate XXIX.

[3] Jackson, C. M., *Archiv für Anat. u. Physiol., Anat. Abth., Jahrg.*, 1904, p. 33, Taf. VII., Fig. 1.

[4] Bidder, Alfred, 1906, "Osteobiologie," *Archiv f. mikros. Anat.*, Bd. 68, pp. 137–210, Taf. X–XIV.

two groups we may use the facts, in the works above referred to, to explain conditions in the Cretaceous plesiosaurs which are inexplicable on any other grounds.

The limb bones of adult plesiosaurs are solid. Young bones nearly always exhibit the canal, cavity and one or more of the foramina above referred to. The fact that the bones are first hollow and later become solid would seem to indicate that the osteolytic elements present in the limb bones of mammals and most reptiles were almost absent, or present in small numbers, in the plesiosaurs and many of the larger dinosaurs.

If the comparison between the developing limb bones of mammals and reptiles is a safe one, then we have here in the young aquatic plesiosaurs of the Cretaceous a condition which persisted until late in life and which recurs in the young of all mammals at the present day. One species of plesiosaur, based on an immature skeleton of an animal some fifteen feet in length, exhibits these conditions in a well-marked manner. Through the openings in the edges of the limb bones of the plesiosaurs, as in the mammals, migrated the osteoblasts or bone-forming cells, the blood vessels and other elements.

The peripheral or perichondral bone was formed first in the plesiosaurs as in the modern mammals, and, through the migration of the bone-forming cells inward, the so-called endochondral bone was a secondary formation. The formation of bone within the endochondrium of the plesiosaurs was, apparently, retarded by some osteolytic agent, possibly the osteoclasts, until the bone-forming elements for some unknown reason attained the supremacy and completely filled the medullary cavity, canal and foramen with solid bone. During this process of filling there resulted, in young bones, a sharp line of separation of the perichondral from endochondral bone, resulting in the formation of curious conical end pieces, formerly called epiphyses, but now known to be the result of bone growth and not epiphyses at all.

Bidder[4] has offered an interesting explanation of the formation of epiphyses in mammals, by the migration of the osteoblasts through special vascular canals (*Canalis vasculosis perforans*) which traverse the space between the medullary cavity and the cartilaginous caps at the ends of the limb bones.

It is interesting to observe in broken and sectioned plesiosaurian propodials an exactly similar condition for this ancient group of aquatic reptiles. The canals are found extending from the medullary cavity to the ends where the bone has been formed in the shape of small conical mounds around the vascular openings, so that in the plesiosaurs the process resulted not in the production of new growths at the ends of the limb bones (epiphyses) but in the elongation of the bone. It is hoped in another place to give a fuller explanation and figures of these interesting relics of Mesozoic osteogenesis.

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THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The regular meeting just held at Columbus (December 27 to January 1) was one of the most successful of the recent meetings of the association. All of the sessions were held in the buildings on the campus of the Ohio State University and members of the association who attended the Columbus meeting of 1899, and who had not visited the university since were surprised and delighted at the enormous growth of the institution and at the character of the many new buildings which had been built since that day. The local committee in charge of the arrangements was extremely efficient and the compactness of the group of buildings and the exceptional meeting room facilities made everything easy for members in attendance.

The opening night for addresses of welcome and for the annual address of the retiring president was in many respects the most impressive function of the kind held under the auspices of the association in the recollection of the writer. In spite of a stormy night the college chapel, seating about 1,200 persons, was completely filled. The address of welcome by President W. O.

Thompson, of the university, and Dr. T. C. Mendenhall, past-president of the association, were extremely happy. Dr. Thompson welcomed the association on the part of the university, city and the commonwealth, and Dr. Mendenhall, finding that his predecessor had included practically all Ohio of to-day in his address, welcomed the association on the part of the shades of deceased Ohio men of science, sketching briefly the career of a number of Ohio's great men of science of the past century. President Eliot's address entitled "The Fruits, Prospects and Lessons of Recent Biological Science" was published in the last number of SCIENCE.

Following the opening meeting a crowded reception was held in the beautiful new library building.

Owing to the death of Retiring Vice-president F. W. Taylor, of Section D, and the absence of Retiring Vice-presidents U. S. Grant, of Section E, and Edgar F. Smith, of Section C, there were no vice-presidential addresses delivered before these sections. The address of Retiring Vice-president Clark Wissler, of Section H, on "Psychological and Historical Interpretations of Culture" and that of R. M. Pearce, of Section K, on "The Work and Opportunities of a University Department for Research in Medicine" were read by title and will be published in SCIENCE.

Addresses by retiring vice-presidents were delivered as follows:

Section A: H. S. White, "Poncelet Polygons."

Section B: Anthony Zeleny, "The Dependence of Progress in Science upon the Development of Instruments."

Section F: F. R. Lillie, "The History of the Fertilization Problem."

Section G: G. P. Clinton, "Botany in Relation to American Agriculture."

Section I: Elmer E. Rittenhouse, "Upbuilding American Vitality, the Need for a Scientific Investigation."

Section L: Paul H. Hanus, "City School Superintendents' Reports."

Section M: L. H. Bailey, "The Forthcoming Situation in Agricultural Work."

There were three public lectures complimentary to the citizens of Columbus. On Tuesday night, Dr. Douglas W. Johnson, "Surface Features of Europe as a Factor in the War." Wednesday night, by Dr. Raymond F. Bacon, Mellon Institute of Pittsburgh, "The Industrial Fellowships of the Mellon Institute: Five Years' Progress in a System of Industrial Service." Friday night, by Dr. Frank K. Cameron, of the Bureau of Soils, Washington, "The Fertilizer Resources of the United States."

The council after an extended discussion adopted the recommendation of the committee on policy to the effect that members of the affiliated societies including the component societies of the old Pacific Association of Scientific Societies, not now members of the Amerian Association, be invited to join the American Association during the year 1916, without payment of the usual entrance fee of $5.00.

Two amendments to the constitution were introduced and will be acted upon at the next annual meeting.

1. Amend Article 22 of the constitution by omitting after the word "Chemistry" in the second line, the words "including its application to Agriculture and Arts."

2. Amend Article 9 of the constitution by adding in line 8 after the words "Permanent Secretary," the words "and the Secretaries of Sections." This amendment, if adopted, will permit the reelection of secretaries of sections, after the expiration of the five-year term and seems especially desirable in case of secretaries who are willing to continue the work.

Dr. Chas. Henry Hitchcock, Dr. Eugene W. Hilgard and Rev. Louis C. Würtele were made life members under the Jane M. Smith fund.

Dr. J. McK. Cattell, Dr. W. J. Humphreys and Professor H. L. Fairchild were reelected members of the committee on policy.

There was, unfortunately, only a small attendance at the meeting of the committee of one hundred on research, and but one report was presented, namely, that by Professor C. R. Cross, chairman of the subcommittee on research funds.

The societies which meet at Columbus in affiliation with the American Association were: American Association of Economic Entomologists; American Mathematical Society; American Microscopical Society; American Nature Study Society; American Physical Society; American Phytopathological Society; American Society of Naturalists; Association of Official Seed Analysts of North America; Botanical Society of America; Entomological Society of America; Society for Horticultural Science; Southern Society for Philosophy and Psychology; Students and Collectors of Ohio Archeology; Wilson Ornithological Club.

The total registration at the association office was seven hundred and fifty, making the meeting one of the largest of the second group. The geo-

graphic distribution of members and attendants was interesting, Ohio naturally leading with one hundred and eighty-one. The other figures are as follows: New York, 59, Michigan 27, Massachusetts 24, Minnesota 18, Missouri 14, District of Columbia 32, Illinois 63, Indiana 34, Iowa 22, Kansas 17, Pennsylvania 31, Wisconsin 25, West Virginia 10, and other states represented by less than 10.

Owing to the impossibility of securing perfect registration, the accurate number of scientific men and women in Columbus can not be stated, but it is safe to say that it approximated nine hundred.

Much interest was shown at the meeting by the citizens of Columbus, and the meetings of all the sections and affiliated societies were extremely well attended. The smokers and dinners were all successful.

The symposia of the meeting were as follows:

Before Section F and the American Society of Zoologists on the topic "The Basis of Individuality in Organisms," the speakers being C. M. Child, E. G. Conklin, O. C. Glaser, C. E. McClung and H. V. Neal.

Before the American Society of Naturalists on the topic "Recent Advances in the Fundamental Problems of Genetics," the speakers being H. H. Bartlett, W. L. Tower, E. M. East, H. S. Jennings and C. B. Davenport.

Before Section I, topic "National Defense and Development," there being twelve speakers.

Before Section K, topic "The Energy Content of the Diet," the speakers being H. P. Armsby, Ruth Wheeler, E. B. Forbes, Carl Voegtlin and C. F. Langworthy.

Before Section M, topic "The Relation of Science to Meat Production," the speakers being W. O. Thompson, H. J. Waters, L. D. Hall, H. W. Mumford and A. R. Ward.

In spite of the fact that the Geological Society of America was meeting in Washington with the Pan-American Congress at the same time, Section E held a very important meeting at which twenty-nine papers were presented, topics relating to the geology of Ohio and adjoining states predominating.

The council passed a resolution to hold a special meeting of the American Association for the Advancement of Science in Washington on January 4, 1916.

Two grants were made by the council, one of one hundred dollars to R. C. Benedict, of Brooklyn, to assist in his investigation of the plants of the fern genus *Nephrolepis*, and one of two hundred and fifty dollars to the Concilium Bibliographicum Zoologicum of Zurich.

A list of the fellows elected will appear in a near number of SCIENCE.

The arrangements for the entertainment of the visiting ladies were exceptionally pleasant and in the resolutions of thanks, which were passed by the council, especial attention was drawn to the admirable work of the ladies' committee, of which Mrs. W. O. Thompson, wife of the president of Ohio State University, was chairman. A very interesting feature was a twilight musical recital with a MacDowell program, which was given on Wednesday afternoon.

Election of officers by the General Committee resulted as follows:

President: C. R. Van Hise, University of Wisconsin.

Vice-presidents as follows: Mathematics, L. P. Eisenhart, Princeton University; physics, H. A. Bumstead, Yale University; engineering, E. L. Corthell, Brown University, Providence, R. I.; geology and geography, R. D. Salisbury, University of Chicago; zoology, G. H. Parker, Harvard University; botany, T. J. Burrill, University of Illinois; anthropology and psychology, F. W. Hodge, chief of the Bureau of Ethnology, Washington, D. C.; social and economic science, Louis I. Dublin, New York; education, L. P. Ayres, of the Russell Sage Foundation, New York; agriculture, W. H. Jordan, director of the New York State Experiment Station, Geneva, N. Y.

The vice-presidents of Sections C and K were not elected, but power was given to the sectional committees to elect. Professor W. E. Henderson, of Ohio State University, was elected general secretary and Dr. C. Stuart Gager was made secretary of the council. Dr. A. F. Blakeslee was elected secretary of Section G and Mr. S. C. Loomis, secretary of Section I.

New York was selected as the place for the Convocation Week meeting of 1916–17, the opening meeting to be held on the night of December 26, and the first council meeting on the morning of December 27, 1916.

The general committee recommended to the general committee of next year the selection of Pittsburgh as the meeting place for 1917–18.

In the absence of the general secretary, Dr. Henry Skinner, of Philadelphia, Dr. Henry B. Ward, of Urbana, acted as general secretary, but the present brief report of the meeting has been drawn up by the permanent secretary.

L. O. HOWARD